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Geological Survey of New-York.

PALÆONTOLOGY:

VOLUME IV, PART I.

CONTAINING DESCRIPTIONS AND FIGURES OF THE FOSSIL BRACHIOPODA

OF THE UPPER HELDERBERG, HAMILTON, PORTAGE AND CHEMUNG GROUPS.

1862-1866.

BY JAMES HALL.

3227
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ALBANY, N. Y.
PRINTED BY C. VAN BENTHUYSEN AND SONS.
MARCH, 1867.

TO HIS EXCELLENCY REUBEN E. FENTON,

Governor of the State of New-York.

SIR :

I HAVE the honor to submit to your Excellency Volume IV., Part I., of the Report upon the Palæontology of New-York, containing the descriptions and figures of the Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung groups. The species are illustrated by figures drawn and engraved from original specimens collected by myself or under my direction, or those derived from other authentic sources.

The completion of the printing has been delayed much longer than I could have anticipated, and the volume should properly have been issued in the early part of 1865.

The plates of this volume, which number sixty-two, with several intercalated ones, are not yet completed, and some time will elapse before they can be finished.

The manuscript, containing descriptions of the CRINOIDEA, CRUSTACEA, GASTEROPODA, CEPHALOPODA, etc. of the higher rocks, forming the fifth volume of the work, was delivered to the custody of the Commissioners having charge of the work in September of last year.

I have the honor to be,

with great respect,

your obedient servant,

ALBANY, March 1867. JAMES HALL.

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PREFACE.

The present volume contains descriptions and figures of all the well determined species of Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung groups of New-York. Some few extra-limital species have been introduced in illustration of the character of neighboring but identical or analogous geological formations, and all these are from well authenticated positions. In several examples of this kind, the same species has subsequently been obtained within the limits of the State ; and we have every reason to believe that most of those, until now known only in Ohio and Canada West, will ultimately be found within the State of New York. In some instances, forms previously described as distinct species have been united under a single specific name. It may perhaps, hereafter be necessary to pursue the same course in regard to a few other examples, when the collections shall become sufficiently extensive to enable us to determine the changes produced by physical conditions, or by the geographical and geological distribution of species.

Although the larger part of the collections used for this volume were made many years since, much new material has been obtained during the past few years. The number of new species, however, is not large, and probably no considerable number will be added to the list of those already known. These later collections have been of great importance for the better determination of the geographical distribution of species, and have confirmed some views on this subject advanced by the author many years since.

While the calcareous formations carry essentially the same fauna from Eastern New-York throughout the length of the State, through Canada West and the State of Ohio, till these limestones disappear beneath the higher formations on the border of Indiana, we find important changes supervening in the fauna of the sedimentary strata.

In Eastern New-York, the coarser sediments of the Hamilton group present proportionally few Brachiopoda ; and in some localities are comparatively barren of all fossils. The Lamellibranchiata, which are the characteristic fossils of the coarser sediments of this group, gradually diminish in number as the finer materials supervene, and the addition of a larger proportion of calcareous matter is accompanied by the advent of great numbers of Brachiopoda, together with Corals and other fossils which are unknown in the eastern part of the State. So great is this change, that were a collection of fossils from the Hamilton group in the counties of Albany and Schoharie to be compared with a collection from the same group in Genesee and Erie counties, the number of species common to both would be less than has been sometimes indicated as passing from one geological formation to another.

The same conditions hold true in a more marked degree in the Chemung group, which, in the counties bordering the Hudson river, is nearly destitute of animal fossils, but contain many plant remains. Farther to the westward, a few lamellibranchiates and brachiopods appear, and their number constantly increases to the central counties of the State, beyond which the Brachiopoda greatly predominate over all the other organisms. Nor is this all ; not only do the Brachiopoda increase in number of species and of individuals, but the species are almost entirely distinct from those in the more eastern localities of the group. We notice, moreover, that in these western localities within the State the prevailing fossils present a "carboniferous aspect," or are of generic and specific forms much resembling the prevailing fossils of the acknowledged Carboniferous rocks of the West. We find also among them a few forms which might readily be mistaken for Carboniferous species ; and in one or two instances, there is scarcely room for specific separation. Here again, in a more emphatic sense, do we find the fauna of the same physical group of strata so entirely unlike at points three hundred miles distant, that there are probably no identical species. At the same time, the entire Chemung fauna of the western counties of New-York presents more analogy with the fauna of the so-called Carboniferous

rocks in the West, than it does with that of the strata of the same absolute age in Eastern New York and in the adjacent portions of Pennsylvania.

Having already, many years since, presented these views, it is not necessary to go farther into the discussion in this place, but merely to remark that further observations and the examination of more extensive collections have confirmed the opinion then expressed, namely, that the distinction between the Devonian and Carboniferous systems is one of geographical rather than geological difference.

In the study of the Brachiopoda, a few changes have been found necessary, beyond what has already been published in the Annual Reports upon the State Cabinet; and some additions have been made to our knowledge of the characters of established genera. In the Genus CHONETES, the observations first made by Count KEYSERLING (but subsequently doubted) of the oblique direction of the tubular spines as they penetrate the substance of the shell along the cardinal line, have been confirmed.

In the shells of productoid form, which are sometimes referred to PRODUCTUS and sometimes to STROPHALOSIA, it has been shown that the narrow area and other external features of the latter genus are accompanied by the vascular imprints of the former. The numerous forms of this character give, to the fauna of the Chemung group, an expression quite similar to that of some of the Carboniferous rocks of the Mississippi valley.

Some additional knowledge has been obtained, regarding the structure of the internal spires in the Genera ATHYRIS, MERISTELLA, and allied forms.

It has appeared desirable to separate, under the sub-generic term STENOCISMA, many of the species hitherto referred to RHYNCHONELLA; and the Genus LEIORHYNCHUS has been adopted for certain forms heretofore thus referred.

Under the pentameroid type it has been found necessary to propose, as distinct genera, PENTAMERELLA, GYPIDULA, ANASTROPHIA and AMPHIGENIA,

while the Genus STRICKLANDINIA is retained for certain forms. It is also proposed to distinguish these allied genera, together with CAMAROPHORIA, as a family PENTAMERIDÆ.

The Genus CRYPTONELLA has been sustained by the character of its internal loop; while the strophomenoid form, TROPIDOLEPTUS, is found to be more nearly allied with the Terebratulidæ than with any other family of the Brachiopoda.

Of the genera described or discussed under the several families, nearly one-half are those which have been proposed from the study of American species of Brachiopoda, and it is believed that they are well-founded in the characters of the typical species. In some of the genera here named, much yet remains to be done in the study of their internal structure, before we shall be prepared to assert positively their entire characters and relations.

The printing of this volume was begun in 1862; but delays beyond the control of the Author have prevented its appearance until now. The plates of the volume are still unfinished at this date, and some considerable time will elapse before their completion. It is hoped that these illustrations may prove acceptable to the student in Palæontology. With the exception of a few plates, the lithography has been executed by Mr. F. J. SWINTON, whose ability and long experience have enabled him to present the work in a very superior manner. The drawings have been made with great care and fidelity by Mr. R. P. WHITFIELD, who has excelled both in the accurate delineation of the character and markings of the species, and also in the preparation of specimens to illustrate the internal structure.

I am greatly indebted to Mr. JOHN PATERSON, for his careful supervision of the volume as it has been passing through the press, and more especially for his kind attention to this matter during some periods of my personal absence.

My acknowledgements are due to many gentlemen for the use of specimens given or loaned to me for study, while the work has been in progress, and of some of these, mention has been made in the body of the work. It is especially gratifying to me to acknowledge the liberality

of Dr. G. A. Williams, formerly of Hardy county, Virginia, now of Boonville, Missouri; and of Dr. James Knapp, of Louisville, Kentucky. Dr. C. Rominger, of Ann Arbor, Michigan, has very liberally given me the use of many specimens illustrating the internal structure of species; and he has placed at my disposal his collection of European and American Brachiopoda for further use in completing an introduction to the study of American Palæozoic Brachiopoda, which is already advanced, and will appear as a supplement to the present volume. I have been indebted to Mr. S. S. Lyon, of Jeffersonville, Indiana, for the means of illustrating the interior of Meristella, (S. G. Pentagonia), as well as for other specimens. I have received from Mr. O. H. St. John, of Waterloo, Iowa, interesting specimens of Brachiopoda, from the Hamilton and Chemung groups of that part of the country. For the illustration of several forms among the Spiriferidæ, I have been permitted the use of specimens from the collection of Col. E. Jewett. From Mr. Joseph Sullivant, of Columbus, Ohio, I have received specimens from the Corniferous limestone of that vicinity; and to the late Dr. Mann, of Milford, Ohio, I have been indebted for many interesting specimens. Through the kindness of Prof. Wright, of Hamilton and Mr. J. De Cew, of Cayuga, Canada West, I have received many specimens of interest from the Corniferous limestone of that region.

It has been to me a great satisfaction, that through many years, I experienced the uninterrupted liberality and kind interest of the late Ledyard Lincklaen, of Cazenovia, whose devotion to geological science never ceased; and it is with a sad heart that I here record this memento of one whose noble manhood was everywhere acknowledged, and whose quiet, but persistent advocacy of an advancing science, has produced many good and permanent results, and has exerted an influence not to be forgotten.

March, 1867.

Note.—In the earlier pages of this volume, printed in 1862, a few species of the genera LINGULA and DISCINA were described from the Waverly sandstones of Ohio, there having been at that time no sufficiently well marked limit established between the western extension of the Chemung Group and these beds. Farther comparison of species of other genera led to a doubt of the propriety of uniting these formations on zoölogical considerations alone, and some species from the Ohio formation, previously described by me, as well as others at that time under investigation, were omitted from the volume for this reason. It is true, however, that certain species found in the Waverly sandstones and associated rocks of Eastern Ohio, are apparently identical with forms occurring in the Hamilton and Chemung Groups of New York; but these are comparatively so few, that their recurrence can only be regarded as due to a repetition of the same or similar physical conditions in the two or more epochs.

At a later period, I have compared the mollusean fauna of the Waverly sandstones with that of some of the conglomerates, at or near the summit of the Chemung Group in Allegany county, New York, and the adjacent parts of Pennsylvania, which contain numerous lamellibranchiate shells. But in all these cases a farther investigation has proved the occurrence of *Spirifera Verneuilii*, a characteristic fossil of the Chemung Group in the same association, while the lamellibranchiate forms, with few exceptions, are altogether of distinct species. In the collections of the Geological survey these fossiliferous conglomerates were arranged as a part of the Chemung Group, while the coarser non-fossiliferous rocks of similar character in Allegany and Cattaraugus counties were considered as outliers of the carboniferous conglomerate. We have since learned, however, that the conglomerate of the southwestern counties of the State is a constituent member of the Chemung Group. The red shaly and arenaceous strata, sometimes observed beneath the conglomerate, are merely subordinate beds of little significance and in no way related to the red rocks of the Catskill Group, to which they have sometimes been referred. The red sandstone, or fine conglomerate, sometimes becoming an impure iron ore, which at one time was referred to as the probable attenuate extension of the red sandstone of Tioga, belongs, for the most part or entirely, to the Chemung Group.

From late investigations in the Geological Survey of Ohio, Dr. Newberry has shown that the beds containing *Spirifera Verneuilii* do actually pass beneath all the strata bearing the characteristic fossils of the Waverly sandstones, and are separated from them by a black shale. This position established, puts at rest any doubts as to the relation of these beds, and until we possessed some ascertained fact of this kind, all discussion upon the question could lead to no definite result.

PALÆONTOLOGY OF NEW-YORK.

The descriptions and illustrations of the fossils in the third volume of this work include those from the Lower Helderberg group and the Oriskany sandstone; while the first part of the present volume, following the formations in the ascending order, will embrace the Brachiopoda of the following rocks and groups:

CHEMUNG GROUP;	
PORTAGE GROUP,	The Genesee slate, forming beds of passage;
HAMILTON GROUP, including the	Tully limestone and Marcellus shale;
UPPER HELDERBERG GROUP, including the	Corniferous limestone, Onondaga limestone, Schoharie grit, and Cauda-galli grit, which rests upon the Oriskany sandstone.

The Cauda-galli grit is almost a non-fossiliferous rock; a few fragments of plant-like fossils, and the peculiar surface markings of the slaty laminæ, from which the name is derived, being the only objects resembling organic bodies which have fallen under my observation. A single specimen of Platyceras, similar to *P. tortuosum* of the Oriskany sandstone, has been found in this rock.

The passage from the Oriskany sandstone to this "Grit," or (as it usually occurs in many localities) arenaceous shale, or shale, is very abrupt and strongly defined. The rock itself is usually a dark or nearly black slaty grit, weathering to a grayish or brownish gray color, with strong lines of jointing or lamination nearly at right angles to the bed-

ding; and these being often close and well defined, while the lines of bedding are obscure, give it the appearance of nearly vertical stratification. This character prevails even when distant from any metamorphic influences. These features distinguish the rock from any other in the series; and even in its smaller outcrops, the vertical lamination has been found a valuable guide in its identification.

In the upper part we find a gradual increase of calcareous matter, with a diminution of the argillaceous material; and it passes, by almost imperceptible gradations, to the Schoharie grit, which is marked by the presence of numerous fossils. The upper beds of the Cauda-galli grit, and also the lower beds of the Schoharie grit, preserve those peculiar markings which have been termed *Fucoides cauda-galli*.

From the base of the Schoharie grit, we begin our investigation among the fossils. In this rock we find, for the first time, a small number of species which pass upward through the limestones of the Upper Helderberg group, and are more abundant in the Hamilton group(1). At the same time, also, we find a few species which are apparently identical with some which we have known in the preceding rocks. These, however, are so few, and being comparatively rare, the large number of new species of the same genera makes them inconspicuous, and we have essentially a new fauna.

One of the most marked features of the change of fauna at this period is the introduction, or appearance for the first time, of numerous species of the Genera CYRTOCERAS, GYROCERAS, etc., with strongly lamellose or fluted surfaces, and which are often ornamented by nodes or spines. Some of the Orthoceratites are marked by sharp lamellose rings, and some of the Gasteropoda are spiniferous. The Trilobites of the Genera

(1) Among those which begin their existence in this rock, occurring likewise in the Upper Helderberg limestones and passing into the Hamilton group, *Orthis vanuxemi?*, *Streptorhynchus chemungensis*, *Strophomena demissa*, *S. perplana* = *S. crenistria*, *Spirifera fimbriata**, *Atrypa impressa* = a variety of the *A. reticularis?* while a larger number of species are common to the grit and to the limestones above.

* Two individuals of this species have been found in the Oriskany sandstone.

DALMANIA and PHACOPS are remarkable for their spiniferous character; while the LICHAS and ACIDASPIS, yet known only in fragments, are of the most extravagant forms of those genera.

Whatever may be the ultimate decision relative to the line of separation between Silurian and Devonian systems, the base of the Schoharie grit offers a much more decided limitation below, than does the Oriskany sandstone. The new fauna bears less relation to the preceding, and many of the new types are of a strikingly distinct character. In the Oriskany sandstone, we have a considerable number of species which first appear in the Lower Helderberg group; and the connection between these two formations is much more intimate than between the Oriskany sandstone and the Schoharie grit.

Since the faunæ of the Schoharie grit and of the succeeding formations, more especially as far as the Hamilton group inclusive, have so many features in common, I have grouped the fossils together, with a view to a more perfect zoological arrangement; and, in the first place, I introduce the BRACHIOPODA of all these formations, designating under each description, as well as in the title of the plate, the rock from which they have been derived.

In arranging the plates, I have followed to some extent the order in which the fossil genera appeared in time, taking care nevertheless to preserve the proper zoological arrangement. The following pages, therefore, with the accompanying plates, will present a pretty full illustration of the BRACHIOPODA now known in these groups, before named, within the State of New-York.

I have sometimes found it necessary to go beyond the limits of the State, to secure specimens fit for the illustration of species known to occur within its limits; and a few extra-limital species have been introduced for the purposes of comparison. In doing this, however, I have taken great care, as I have always heretofore done, to avoid deriving specimens from any portion of the country, or any State, where surveys have been going on, in which a department of palæontology has been organized, and whence we might have reasonable expectation of seeing the fossils described and illustrated.

The following list, in the order in which they are described, embraces all the genera of Brachiopoda at this time known to me in the rocks and groups previously noticed on the first page, and from which species are described in this volume.

LINGULA,
DISCINA,
CRANIA,
PHOLIDOPS,
ORTHIS,
STREPTORHYNCHUS,
STROPHOMENA,
STROPHODONTA,
CHONETES,
PRODUCTUS = PRODUCTELLA,
SPIRIFERA,
CYRTIA and CYRTÆNA,
TREMATOSPIRA,
RHYNCHOSPIRA,
RETZIA?,
NUCLEOSPIRA,
ATHYRIS,
MERISTA,
MERISTELLA,
ATRYPA,
CŒLOSPIRA,
RHYNCHONELLA,
STENOCISMA,
LEIORHYNCHUS,
LEPTOCŒLIA,
CAMAROPHORIA,
PENTAMERUS,
PENTAMERELLA,
GYPIDULA,
AMPHIGENIA,
RENSSELÆRIA,
TEREBRATULA,
CRYPTONELLA,
CENTRONELLA,
TROPIDOLEPTUS,
VITULINA.

*** There are one or two other genera, which may be ultimately included in the list occurring in these formations.

Genus Lingula (Bruguiere).

Up to the time of commencing the printing of this volume, I do not know of more than a single species of Lingula in the Schoharie grit, and but two in the Upper Helderberg limestone.

Several species occur in the limestones of the Lower Helderberg group, and which have been already described; but none are known to occur in the Oriskany sandstone, and but three species between that rock and the Marcellus shale or base of the Hamilton group. Collections of considerable extent have been made, and over a large area of country; and judging from these, the shells of this genus were extremely rare in the early epochs of the Devonian period in this country. The species are for the most part rare in the Hamilton group, so far as my examinatons have extended, and one only is known to be abundant.

LINGULÆ OF THE UPPER HELDERBERG GROUP.

Lingula ceryx (n. s.).

PLATE II.

A single specimen has been obtained, three-fourths of an inch in length by half an inch in breadth. Very little of the shell is preserved; merely sufficient to show that it was marked by fine concentric striæ, with the cardinal margin thickened. The cast has a distinct oval impression a little above the centre, showing the mark of a muscular callosity at that point.

This species resembles in form the *L. dèusa* of the Hamilton group, but has not the strong radiating striæ of that species, while the subcentral muscular callosity is also different.

Except that this is the only representative of the genus known to me in the Schoharie grit, I would not have thought it worth while to desiguate the species from a single imperfect specimen.

Geological formation and locality. In the Schoharie grit : near Clarksville, Albany county, New-York.

Lingula desiderata (n. s.).

PLATE II.

SHELL robust, elliptical, convex, the width equal to about four-sevenths of the length, the greatest width being above the middle of the shell. SURFACE marked by fine and closely arranged concentric striæ; the interior of the shell, and the cast, showing strong radiating striæ. Length a little less than half an inch.

The specimen is apparently a dorsal valve, which is truncate, and perhaps a little imperfect at the beak. In its general form it resembles *L. ligea*, but is wider above the centre and more convex, while it is larger than any specimens of that species in the collection. The presence of radiating striæ has not been observed in *L. ligea*. Other specimens are required for a satisfactory determination of its character.

Geological formation and locality. In the Corniferous limestone of the Upper Helderberg group, at Lapham's mill, Ontario county, N. Y.

Lingula manni (n. s.).

PLATE II.

SHELL somewhat obovate, the cardinal end being narrower and rounded; gradually expanding in width for more than two-thirds the length, becoming slightly narrower below, with the baso-lateral angles very abruptly rounded : basal margin nearly straight. Surface marked by fine close concentric striæ, which are scarcely elevated above the smooth glossy surface. Shell thin : valves nearly flat.

One specimen measures three-fourths of an inch in length by half an inch in its greatest width, while the width one-third the length below the posterior end is three-eighths of an inch.

Two separate valves are all that have been seen of this species, but it differs sufficiently from all the others in these strata to be readily recognized. This and one other are the only species of LINGULA, at this time known to me, in the limestones of the Upper Helderberg group.

The specimens were received from Dr. R. P. MANN, of Milford, Delaware county, Ohio.

Geological formation and locality. In limestone of the age of the Upper Helderberg limestone, in Delaware county, Ohio.

LINGULÆ OF THE HAMILTON GROUP,

INCLUDING THE MARCELLUS SHALE.

Lingula exilis.

PLATE I.

Lingula exilis : Hall, Thirteenth Report of the Regents on the State Cabinet, 1860, p. 76, f. 2.

Shell broad-ovate, moderately convex, length little greater than the width; apex obtuse; cardinal margin obtusely rounded; sides regularly curving; base broadly rounded. Surface lamellose, with irregular rugæ or lines of growth.

The specimens obtained are imperfect at the beak, or in some other part. The shell is very broad; and the great width at the apex, and broadly rounded cardinal extremity, distinguish it from all other forms of the Hamilton group, or of the rocks of New-York. In the normal condition, the umbo appears to have been quite prominent; but the specimens occurring in the thinly laminated strata are much flattened.

It is associated with Discina and Conularia, similarly with those of the Trenton group in New-York.

Geological formation and locality. In the Marcellus shale, near Bridgewater; and an imperfect specimen has been found in the shales of the central part of the Hamilton group, in Schoharie county, New-York.

Lingula ligea.

PLATE I.

Lingula ligea : Hall, Thirteenth Report of the Regents on the State Cabinet, 1860, p. 76.

Shell narrow elliptical; length equal to twice the width; sides regularly curving; extremities subequal; margins of the valves thickened. Surface marked by fine concentric striæ, and by a few obscure or obsolete radiating striæ. The more convex valve shows, along the inner margin, a narrow shallow groove as if the edge of the opposite valve closed just within its margin.

The shell is of more equal width throughout and more symmetrically oval, and also much larger than the *L. spatulata* of the Genesee slate. It is likewise more prominent along the centre of the upper half of the shell. One valve (the ventral ?) appears to have been more convex than the other.

Geological formations and locality. In the shales of the upper part of the Hamilton group, on the banks of Seneca lake.

Lingula ligea, var.

PLATE II.

The specimens from the lower part of the Portage group are larger than those from the Hamilton group, and have the sides somewhat straighter; while the cardinal extremity is not so rounded, and slopes in nearly a right line on each side of the beak. The surfaces are not so well preserved as in those of the Hamilton group. This may ultimately prove to be a distinct species.

Geological formation and locality. In the arenaceous shales of the Portage group : at the falls below Trumansburgh, New-York.

Lingula palæformis.

PLATE I.

Lingula palæformis : Hall, Thirteenth Report of the Regents on the State Cabinet, p. 76.

Shell broadly subovate; sides sloping in a nearly straight line from the beak to half the length of the shell, convex at the umbo and depressed below, the length a little greater than the greatest width, rapidly expanding for about two-thirds the length of the shell, below which it is abruptly rounded : shell thick. Surface marked by strong concentric lamellose striæ, and, in the exfoliated surface, by fine radiating striæ.

This species, in general form, resembles the *L. spatiosa* of the Lower Helderberg group, but differs conspicuously in the surface striæ ; and among a considerable number of specimens, the dimensions are the same as the specimens figured, being nearly two-thirds the length of the Lower Helderberg species.

Geological formation and locality. In the shales of the Hamilton group ; associated with numerous known fossils in a loose fragment of rock, found in the valley south of Cayuga lake.

Lingula leana (n. s.).

PLATE II.

SHELL robust, ovate, subattenuate towards the beak; margins gradually expanding and curving from the beak for about two-thirds the length, where the shell has its greatest width. Lower half of the shell very depressed-convex, becoming more convex towards the beak. Shell comparatively thick, lamellose.

SURFACE marked by fine concentric striæ and faint interrupted radiating striæ, which are more conspicuous and continuous in the exfoliated shell. The length of an apparently full grown individual is eight-tenths of an inch, and the greatest width eleven-twentieths of an inch.

This species is conspicuously distinct from any others in the Hamilton and Chemung groups, except *L. palæformis*, from which it differs in its greater proportional length and more attenuate form towards the beak. So far as known to me, it is a rare species.

Geological formation and locality. In some calcareous layers in the Hamilton shales, in Bristol, Ontario county, N.Y.

Lingula maida (n. s.).

PLATE II.

SHELL linguiform, elliptical, greatest width a little more than half the length, narrowing gently towards either extremity, obtusely rounded and produced below, and more acutely converging towards the beaks.

SURFACE very gently convex below and a little more convex on the umbo, marked by fine threadlike striæ which are sometimes crowded in fascicles. No radiating striæ are preserved in the specimen.

The specimen described is apparently a ventral valve, and preserves some remains of the muscular impression. In form it resembles the *L. ligea*, but is less convex, and the lower part of the shell is more produced, so that the striæ make a more extended curve than on that species; and they are likewise coarser.

The typical forms of *L. ligea* are about half an inch in length and one quarter of an inch in width; and the *L. maida* has a length of more than three-fourths of an inch, with a width of nearly half an inch.

Geological formation and locality. In the Moscow shales of the Hamilton group: at Moscow, N.Y.

Lingula punctata (n. s.).

PLATE I.

Shell subelliptical, length and breadth as three to two; sides parallel; base subtruncate; cardinal slopes abrupt, and but little curved; umbones prominent, somewhat flattened in the middle below the longitudinal centre, the flattened space expanding towards the base. Ventral valve a little more convex than the opposite.

Surface marked by concentric wrinkles; the entire structure punctate or subpunctate, sometimes corrugate, with extremely fine striæ. Muscular impressions, in the cast or partially exfoliated shell, subcordate below, with numerous diverging foliate imprints above.

The length of the shell varies in different individuals from one-half to three-fourths or even seven-eighths of an inch, and the width of the larger specimens is half an inch. The surface marking is peculiar and characteristic, the apparent punctate structure being caused by two sets of concentric or irregularly wrinkled striæ, leaving minute pits between them. In this character, which is preserved more or less even upon the casts or exfoliated surfaces, the species is readily identified.

It resembles in general form the *L. rectilateris* of the Lower Helderberg group, but is less rounded on the cardinal slopes and less convex on the lower half of the shell, while the base is much more abruptly truncate.

Geological formation and locality. In the shales of the Hamilton group: Monteith's Point, on Canandaigua lake; and near Summit in Schoharie county, N.Y.

Lingula nuda (n. s.).

PLATE II.

Shell subelliptical; length nearly twice as great as the width; sides subparallel, very slightly curving, the greatest width near the centre; base truncated; cardinal slopes rounded, the ventral valve a little more pointed and more convex than the dorsal valve. Dorsal valve nearly flat. Ventral valve, in exfoliated specimens, marked by a depressed line down the centre, with indications of foliate muscular impressions upon each side. Surface marked by fine concentric striæ, which, on the margins, are crowded and wrinkled.

This shell resembles *L. punctata* in form, but is proportionally narrower : it is truncate in front in the same manner; the umbo is a little narrower, and it has not the flattened space below the middle so distinctly indicated. The surface marking, however, is always a more distinctive character. The largest specimen examined, little exceeds half an inch in length.

Geological formation and locality. In the shales of the Hamilton group, associated with *L. punctata :* near Monteith's Point, on Canandaigua lake.

Lingula densa (n. s.).

PLATE II.

Shell subelliptical; sides almost exactly parallel for more than half the length of the shell, abruptly curved at the basal angles, and the base nearly straight or slightly curving; cardinal margins gently curving. Middle and upper part of the shell prominent and rounded; one valve (ventral?) showing a slight longitudinal depression when exfoliated, with fine wrinkled muscular impressions. Valves somewhat abruptly flattened and compressed below the middle.

Shell comparatively thick, compact, and very closely and finely striated concentrically, with undulating striæ, the exfoliated shells showing radiating striæ.

This species has nearly the same form as *L. punctata*, but is more robust and more abruptly elevated along the middle of the upper half of the valve : the flattening is only near the lower extremity, and does not extend upwards in a triangular form as in that species. The absence of puncta, and the close scarcely elevated fine striæ, are distinguishing features.

Geological formation and locality. In the upper part of the Hamilton group, near Summit, Schoharie county; occurring in large numbers in some semi-arenaceous layers on the small stream flowing in a gorge known as "Bear Gulf."

Lingula delia (n. s.).

PLATE II.

Shell elliptical, twice as long as wide; sides gently curving; base very regularly rounded; cardinal slopes abrupt, nearly straight: substance of the shell very thin. Surface marked by extremely fine concentric striæ, and, below the centre of the shell, by numerous undulations, which are stronger on the middle and become obsolete on the sides.

In the ventral? valves, a strongly impressed linear indentation marks the centre of the shell from near the beak more than halfway to the base. This feature is observed in the best preserved specimens seen, as well as in partial casts. An apparently adult specimen measures nine-tenths of an inch in length, and five-tenths in the greatest breadth.

This species differs conspicuously from all others of the Hamilton and Chemung groups, except the *L. maida*, which is proportionally shorter, with more attenuate cardinal extremity and stronger surface striæ.

In general form, this species bears some resemblance to *Lingula ovata* of M'Coy (British Palæozoic Fossils, Pl. 1 L, f. 6), having the same slender form; but the sides are not so straight, and the front is more curved. It has not, however, the robust form of that species as represented in figure 1, Plate III, of the Synopsis of the Palæozoic Fossils of Ireland.

Geological formation and locality. In the shales of the upper part of the Hamilton group, near Canandaigua lake.

Lingula alveata (n. s.).

PLATE II.

Shell subelliptical; sides curving, broader below the middle, somewhat abruptly expanding and curving from the beak for more than one-third the length of the shell.

Two separate valves examined (one of them a cast), are flat, and have a somewhat elevated or thickened border, extending from the beak,

within which is a distinct groove nearly parallel with the margin and reaching half the length of the shell : the centre is marked by a longitudinal linear impression for more than half its length ; and the cast of one specimen preserves the mark of a thin septum, which extends from just beneath the beak three-fourths the length of the shell.

One specimen is nearly an inch and a half long, and the other one inch and one-eighth. The thickened border and thin median septum are distinguishing features.

There are some peculiarities in these specimens, which lead me to suppose that a full knowledge of their characters and interior structure may authorise their separation from the ordinary forms of Lingula.

Geological formation and locality. In the shales of the Hamilton group, Ludlowville, Cayuga county; and in a sandstone near Fultonham, Schoharie county.

Lingula spatulata.

PLATE I.

Lingula spatulata : Geological Reports of the Third and Fourth Districts, N.Y., 1842 & 1843.

Shell small, subspatulate or subelliptical, moderately convex, attenuate towards the beak, the ventral valve being more acute ; greatest width across the middle of the shell ; length (which is scarcely three-tenths of an inch) about twice as great as the width. Surface marked by fine concentric striæ, and, in the exfoliated shell, by faint radiating striæ.

This little shell, without any very conspicuous features, is usually recognized without difficulty by its small spatulate form. It is frequently abundant in the Genesee slate, and, so far as known, is confined to that rock; though its associate, the *Discina lodensis*, occurs in the black slaty layers in the Hamilton group below.

Geological formation and locality. In the Genesee slate, near Lodi and Bigstream Point on Seneca lake; and near Ogden's Ferry, on Cayuga lake.

LINGULÆ OF THE CHEMUNG GROUP.

Lingula melie (n. s.).

PLATE I.

Shell elliptical; length and breadth about as three to two, the width often a little greater; moderately convex, the umbo prominent, and below it begins a narrow flattened space, which, very gradually widening, reaches to the base. (This feature is noticed on the ventral valves.) Sides curving, the margins flattened or a little recurved. Beak of the ventral valve extended and acute; and in partially exfoliated specimens there is a depressed sublinear area reaching more than one-third the length of the shell, and margined on each side by a sharp line.

The specimens, which appear to be the ventral valves of the same species, are obtuse at the cardinal extremity, and proportionally wider towards the base. The most extreme example of this kind is shown in fig. 3, while fig. 4 is the extreme of the other form. The surface characters are the same in all the specimens, and, on the exterior shell, consist of fine concentric striæ which are crowded at intervals into ridges, giving an undulating surface. On the exfoliated fossil, the concentric wrinkles are preserved with faint impressions of the striæ; and obscure radiating coarser striæ mark the surface, becoming stronger towards the margins, and terminating just within the edge in minute depressions or puncta.

This species, in some of its forms, resembles the *L. spatulata*, but is larger, and also very distinct in the details of its surface markings.

This species occurs at Chagrin Falls, Ohio, in strata of the age of the Chemung group.

Lingula cuyahoga (n. s.).

PLATE I.

Shell subelliptical; length and breadth about as five to three; sides nearly parallel, narrowing a little towards the cardinal margins; beak obtuse; cardinal slopes very little inclined; base abruptly rounded. Surface marked by fine concentric striæ, and, on the exfoliated surface, by fine obscure radiating striæ.

A single valve (ventral?) is very convex along the middle for two-thirds of the length; the front rather depressed, and the entire margin, from the cardinal extremities, flattened. This specimen is in sandstone. Another imperfect specimen in soft shale has nearly the same proportions, but is flattened, and the cardinal slopes less nearly rectangular to the axis.

The species is a well-marked and very distinct form, occurring in the thin arenaceous layers at Cuyahoga Falls, and in the green shale at Akron, Ohio, in strata referred to the upper part of the Chemung group of New-York, or Waverly sandstone group of Ohio.

Genus Discina (Lamarck).

This genus, though occurring in the Lower Helderberg group and in the Oriskany sandstone, is at present known to me in a single species only, in the Schoharie grit and in the Upper Helderberg limestones. It is known in two species in the Marcellus shale: one species is very abundant in the Hamilton group, and another in the Genesee slate; while the other known species are not of frequent occurrence.

DISCINÆ OF THE HAMILTON GROUP.

Discina minuta.

PLATE I.

Orbicula minuta : Hall, Geological Report on the Fourth District, 1843, p. 180.

Shell minute, subcircular, plano-convex. Dorsal valve moderately convex, except near the apex, which is more abruptly elevated; apex of the dorsal valve excentric, and directed forward. Ventral valve flat; foramen excentric, with sometimes a slight sinuosity in the margin on that side of the shell. Surface marked by fine crowded and wrinkled striæ.

In well-preserved specimens the surface is black and shining, but this condition is not always maintained.

The specimens have usually the greater diameter one-twentieth, varying to three-twentieths of an inch. The species is extremely abundant in some layers of the Marcellus shale, but is not known to have any great vertical or horizontal range. Its extreme minuteness distinguishes it from any other species known to me in the New-York formations.

Geological formation and locality. In the Marcellus shale : near Avon, N.Y.

Discina humilis (n. s.).

PLATE II.

Shell of medium size, circular or subcircular, very depressed-convex on the dorsal side; apex subcentral. Ventral valve flat, with apex subcentral; foramen apparently submarginal.

Surface, from the apex halfway to the margin, marked by fine concentric striæ, and outside of this by a few comparatively distant sharp elevated striæ, with the intermediate spaces scarcely perceptibly striate.

Two specimens only of this species have been recognized : the larger of these has a diameter of more than an inch; and the smaller one, about three-fourths of an inch. They are more nearly circular than any other species in the Marcellus shale and Hamilton group, except the *D. minuta*. The *D. lodensis* is sometimes circular; but its prevailing form is broad oval, and it is always closely and finely striated, and, in this feature, very distinct from the present species.

Geological formation and locality. In the Marcellus slate, near Bridgewater; and in the shales of the Hamilton group, on Canandaigua lake.

Discina grandis.

PLATES I & II.

*Orbicula grandis** : Vanuxem, Geological Report Third District, 1842, p. 152–3, f. 4.

General form broadly and transversely elliptical, plano-convex or concavo-convex. Dorsal valve sometimes extremely elevated; apex subcentral, a little on one side of the transverse axis. Ventral valve usually moderately concave; foramen reaching from the centre or near the centre towards one side, but varying somewhat in different individuals.

Surface marked by fine concentric striæ, crowded near the centre, and more distant and sharply elevated towards the margin.

This species is recognized by its large size, and in the ventral valve by the direction of the foramen being in the shorter diameter of the shell. This valve is somewhat unequally concave, and, on the side of the foramen, often a little convex. The dorsal valves of two specimens, which appear to be of this species (one of them with ventral valve attached), are very different in their degree of convexity, and may prove distinct.

In different specimens, this species has a transverse diameter of one inch and a quarter to one inch and five-eighths, with a longitudinal diameter of one inch and an eighth to one inch and a quarter.

The original figure of Vanuxem, given below, is of the ventral valve. A single specimen retaining the two valves in connexion, has been observed; while a separate valve of this, or an allied species, has been found in the same association. So far as the collections yet obtained furnish evidence, this species is very rare; and but a single fragment (and this may be questioned) has been found to the west of Cayuga lake.

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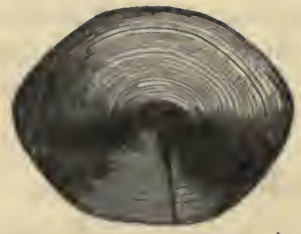
* This name was overlooked at the time of describing the species in the Oriskany sandstone, and will be superseded for that species, the one under consideration having precedence. I propose for the Oriskany form the name *Discina ampla*.



DISCINA GRANDIS (Vanuxem).

Geological formation and locality. In the compact arenaceous shales, at Cazenovia, and at Pratt's falls in Onondaga county; and a single fragment has been found near Moscow, Genesee county.

Discina randalli (n. s.).

PLATE II.

VENTRAL valve circular or nearly circular, gently concave within the margin: foramen large, marked by a broadly oval depression on the exterior surface, which reaches half the distance from the apex to the margin.

SURFACE marked by strong rounded concentric ridges with sharp depressions between, and sometimes with finer concentric striæ upon the coarser ones; all of them crossed, on the posterior margin of the shell, by fine radiating striæ or vascular impressions, which enter into the substance of the shell. On the anterior half of the shell, the concentric striæ become partially obsolete. From a constricted ridge, which externally marks the place of a median septum in the muscular impression, there diverge strong rounded radiating ridges, separated by narrow abrupt depressions which extend nearly or quite to the margin of the valve.

The single specimen known is a partially exfoliated exterior surface of a ventral valve: the margin of the anterior portion is somewhat broken and worn away. Certain appearances indicate that the dorsal valve lies beneath this ventral valve, imbedded in the matrix, and the two pressed closely together.

This species is a large and remarkable form; the transverse diameter is nearly three inches, and from the apex to the posterior margin is one inch and a half.

The anterior side being broken off, we infer, from the ordinary proportions of these shells, that it has been at least as long as the posterior part, which gives a longitudinal diameter of three inches. The concentric striæ are stronger than in any of the other species in these rocks, and the strong radiating ridges are a very distinguishing feature.

This is the largest well-authenticated Discina that I know; though I have a discoid fossil under consideration, possessing the general appearance of Discina, which in its greatest diameter is four inches.

Geological formation and locality. In the arenaceous shales of the Hamilton group : near Schoharie.

Discina doria (n. s.).

PLATE II.

Shell subcircular or oblate, the transverse diameter usually the greater. Dorsal valve convex; apex elevated, subterminal. Ventral valve flat or concave, the apex excentric; foramen comparatively large, oval, with margins depressed. Shell thin.

Surface marked by fine concentric striæ, and the cast by folds or wrinkles in the same direction.

This species closely resembles the *D. newberryi*, from Cuyahoga falls, Ohio; but that shell is somewhat thicker and stronger, with the apex of the dorsal valve more elevated. The specimens of the present species observed are likewise smaller. The presence or absence of the radiating striæ on the cast, which are probably caused by the soft parts of the animal, cannot be relied upon as characteristic. The length of the largest specimen is about three-tenths of an inch, with a width of seven-twentieths of an inch.

The most characteristic specimens of this species which have been seen, are adhering to other fossils; and its identity with Discina might be questioned, but for the preservation of four individuals (one of them a ventral valve) upon a specimen of *Pleurotomaria sulcomarginata*. The same species occurs in Canada West, attached to Spirifer.

Geological formation and locality. In the Hamilton group : at Hamilton; on the east shore of Seneca lake, N.Y.; and in Canada West.

Discina seneca (n. s.).

PLATE II.

Dorsal valve broadly oval; apex about one-third from the posterior margin, and, in a specimen six-tenths of an inch in length, is elevated one-tenth of an inch above the plane of the margins.

Surface marked by concentric, somewhat regular folds or wrinkles in the larger specimens, and, in a smaller one, the surface is similar, but less uneven; the concentric markings being more like undulations of the surface, than the ordinary striæ of Discina.

Two specimens of dorsal valves only have been seen: they have the same form as *D. media* and *D. lodensis;* but the apex is much more elevated, and the surface striæ are not of the same fine and regular character, though, the specimens being partial casts, this feature may be somewhat obliterated. One of the specimens has a length of six-tenths of an inch, with a width of five-tenths; while the smaller one has a length of one-fifth, and a width of one-sixth of an inch.

These specimens occur in the same shale with the other species, which are always flattened, while both the old and young of this maintain their proportions as described. With the single larger specimen, I hesitated to characterize the species; but finding a small one of the same form and character, I can scarcely indicate it as a variety of either of the other species which it resembles in general form.

Geological formation and locality. In the upper part of the Hamilton group: on the east shore of Seneca lake.

Discina media (n. s.).

PLATE II.

Compare *Discina lodensis*, pa. 22, pl. 2.

Shell broadly elliptical or subcircular, variable in form. Dorsal valve very depressed-convex; apex excentric, pointed, and inclined towards the posterior border. Ventral valve flat, or a little convex just anterior to the foramen; foramen narrow, directly in the longitudinal axis of the shell, or often a little oblique.

Surface finely and evenly striated by fine regular elevated striæ, distant from each other more than twice their width. The apex of the dorsal valve is about one-third, and sometimes less than one-third the length of the shell from the posterior margin. Perforation of the ventral valve narrowly oval or sublinear, about one-third the length of the shell from the posterior margin, and extending towards the edge of the shell.

This species resembles in form the *D. lodensis* of the Genesee slate; but it is more coarsely and distantly striated, and does not present the radiating folds or undulations observed in that species. The position and relations of the apex and foramen are similar to those of the *D. lodensis;* and it is possible that conditions of the sediment, and other physical causes, may have affected the external characters, and that we have only a well-marked variety of that species. The species is not uncommon in the Hamilton group, both in the bluish shales and in the dark slaty beds, which are of the same character as the Genesee slate.

A single specimen of a ventral valve, found in the upper part of the Chemung group in Steuben county, possesses characters so entirely similar to those of the Hamilton group, that I can find no means of separating it.

The oval form and excentric position of the apex are sufficient to distinguish the species from others of these groups. The elliptical specimens measure half an inch, or more, in length, with a width of nine-twentieths of an inch.

Geological formation and locality. In the Hamilton group, on the shores of Seneca lake near Ovid, and in the upper part of the group on the shores of the Canandaigua lake; and in the green shale of the Chemung group in the south part of Steuben county, at Troupsburgh.

Discina (sp.?).

PLATE II.

A small nearly circular specimen of a ventral valve, occurring in the Marcellus slate, is marked by fine crowded and scarcely distinct striæ: the apex is excentric, being scarcely more than one-third the length of the shell from the posterior margin; with a short, narrowly oval foramen.

This specimen is unlike any other one before me, and may be a distinct species; but I hesitate to designate it without more material.

Geological formation and locality. In the Marcellus slate: near Bridgewater, N.York.

Discina tullia (n. s.).

PLATE II.

Dorsal valve elliptical; apex excentric, elevated above the plane of the margins of the shell nearly one-eighth of an inch; length half an inch, and breadth little more than three-tenths of an inch.

Surface marked by fine crowded striæ.

A single specimen of the dorsal valve only has been seen, but its proportions of length and height distinguish it from any other species in the rocks of New-York.

Geological formation and locality. In the Tully limestone near Ovid, Seneca county, N.Y.

Discina lodensis.

PLATE II.

Orbicula lodensis : Hall, Geological Report Fourth District, p. 223.
— — : Vanuxem, Geological Report Third District, p. 168.

Shell broadly oval-ovate or subcircular, narrower towards the posterior end. Dorsal valve very depressed-convex; apex minute, excentric, less than one-third the length of the shell from the posterior margin. Ventral valve flat towards the margins, and somewhat abruptly elevated at the apex; foramen linear, extending more than halfway from the apex to the margin, and sometimes causing an undulation of the edge, or slight emargination.

Surface finely striated concentrically by close crowded and little elevated striæ, and, on the anterior half of the shell, by faint radiating folds or undulations. In partially exfoliated specimens, radiating marks of the vascular impressions are perceptible. Specimens rarely show the concentric striæ to be crenulated by delicate radiations, a character which undoubtedly existed in all perfect shells.

In the partially exfoliated shells, the apex of the dorsal valve shows a

narrow indentation on the anterior slope; and in ventral valves in similar condition, there is sometimes a lobed muscular impression just anterior to the foramen.

This species is very abundant in certain localities of the Genesee slate. Tho oval-ovate forms rarely or never exceed nine-twentieths of an inch in length, by eight-twentieths in the greatest width. The largest subcircular form obtained has a length a little less than half an inch, with a width of full half an inch in its greatest diameter, the posterior end being truncate.

In form and proportions, this shell scarcely differs from the *D. media*, but is smaller than the generality of that species, the striæ much finer and closer, and it possesses the faint radiating folds which do not appear in that species.

Geological formation and locality. In the Genesee slate, above the Hamilton group : near Lodi and Bigstream point, Seneca county, N.Y.

Discina truncata (n. s.).

PLATES I & II.

Shell ovate, the anterior end broader : valves depressed-convex. Dorsal valve with the apex near the posterior margin, and directed backwards; posterior margin very abruptly rounded or truncate. Ventral valve with the apex submarginal; foramen extending nearly or quite to the posterior margin, which is indented.

Surface marked by fine concentric striæ and faint radiating undefined lines.

This little species scarcely ever exceeds two-tenths of an inch in length; while the greatest breadth, which is anterior to the middle, is nearly the same. The dorsal valve has the appearance of a Lingula, with flattened margin extending beyond the beak : the ventral valve shows a submarginal foramen. The muscular impressions (which are faintly preserved) differ from the ordinary Discina, but are too obscure to afford means of separating it from the genus.

In some specimens the posterior margin is abruptly rounded, while in others it is straightly truncate. It may, perhaps, have been an elongated form of this shell which is figured as *Lingula concentrica* in the Geological Report on the Fourth District.

Geological formation and locality. In the Genesee slate : near Lodi, and at Bigstream point, Seneca county.

DISCINÆ OF THE CHEMUNG GROUP.

Discina neglecta (n. s.).

PLATE I.

SHELL elliptical. Dorsal valve convex : elevation of the apex above the plane of the margins about one-twelfth of an inch ; apex situated about one-third the length of the shell from the posterior margin.

SURFACE marked by crowded wrinkled concentric striæ.

A single specimen of the impression of the dorsal valve measures seven-tenths of an inch in length, with a width of six-tenths of an inch. The dorsal valve of another specimen of similar character is more nearly circular, the concentric striæ are thin and elevated, and the interior shows a linear muscular impression.

Other specimens are required for a full determination of the characters of the species. It is a more robust form, with the apex more elevated, than the *D. lodensis;* and the specimens may be compared with *D. seneca.*

Geological formation and locality. In the arenaceous shales of the Chemung group, from the Inclined Plane at Ithaca, Tompkins county, N.Y.

Discina elmira (n. s.).

PLATE II.

DORSAL valve very convex, transversely broad-oval ; breadth about seven-tenths of an inch, and length half an inch : apex excentric, or about one-third from the posterior margin. Ventral valve unknown.

SURFACE marked by extremely fine crowded striæ.

This specimen of the dorsal valve only, is noticed in anticipation of obtaining materials for a full illustration. In the elevated dorsal valve, position of apex, and fine striæ, it bears some resemblance to the dorsal valve of *D. grandis.*

Another specimen of similar character, but with the apex a little more depressed, has a length of half an inch, with a transverse diameter of about one inch. This specimen is essentially a cast in sandstone, and its surface markings are not clearly preserved ; but it shows no important difference from the preceding one, and for the present I unite the two under the same designation.

Geological formation and locality. In the shales of the Chemung group : near Elmira, N.Y., and in sandstone of the same group near Wellsborough, Pa.

Discina alleghania.

PLATE I.

Discina alleghania : HALL, Thirteenth Report on the State Cabinet, p. 77.

SHELL broadly elliptical or nearly circular. Dorsal valve depressed conical; anterior side broadly and equally convex; apex placed at a little more than one-third the length from the posterior end of the shell, slightly inclined backwards; the posterior slope concave, and the shell flattened towards the margin.

SURFACE marked by fine regular concentric lamellæ, which are distant from each other two or three times their width.

This large species is one of the finest and most beautiful of the genus, nearly equal in size to the *D. ampla* of the Oriskany sandstone, and differing from that one in the posterior position of the apex and the more abrupt sloping on the posterior side, while the concentric striæ are much finer and more closely arranged. It differs from the large circular form *D. discus* of the Lower Helderberg group, in the greater elevation of the dorsal valve, and absence of radiating striæ.

This species differs from the *D. grandis* of the Hamilton group in the position of the apex of the dorsal valve, and in the direction of the foramen relative to the greatest diameter of the shell.

Geological formation and locality. In the Chemung group, Hobbieville, Allegany county, N.Y.

DISCINA ALLEGHANIA.

Discina newberryi (n. s.).

PLATE I.

SHELL subcircular or broadly ovate, sometimes oblate : apex situated near

the posterior margin or less than one-fourth the length of the shell therefrom, prominent, being from less than one-eighth to one-quarter of an inch above the plane of the margins. Ventral valve slightly concave; apex excentric; foramen large, oval, with the margins deeply depressed. Shell comparatively thick and strong.

Surface marked by fine concentric lines, which are very faint in young shells, but become stronger and rise into distinct sharply elevated striæ in older specimens.

Where partially exfoliated, the shell shows intermediate fine radiating striæ; and in older specimens, the interior of the shell, and likewise the cast, is marked by strong radiating vascular impressions. The structure of the shell is strongly lamellose. The casts of the dorsal valve show a narrow longitudinal muscular impression on the anterior side of the beaks. The length varies from one-eighth to one inch.

For these specimens, I am indebted to Dr. J. S. Newberry.

Geological formation and locality. Abundant in a ferruginous band about 110 feet below the Conglomerate at Cuyahoga falls, and in the green shale and shaly sandstone at Akron, Ohio.

Genus Crania (Retzius).

Up to the present time, the Genus Crania has not been recognized in the New-York collections, from any rock below the Schoharie grit.

The extensive and long continued explorations in the Lower Helderberg group, which resulted in the discovery of many rare and obscure fossils of that formation, we may suppose would have brought to light any species of this genus which might have lived in the area of investigation. Still we are far from being warranted, by this negative information, in the inference that this genus did not exist in the preceding periods in the New-York strata, since we know of its occurrence in rocks of the age of the Niagara group in Indiana. At this time we know of but two individuals in the Schoharie grit, notwithstanding that collections have been made from that rock during the past twenty-five or thirty years.

CRANIÆ OF THE UPPER HELDERBERG GROUP.

Crania aurora (n. s.).

PLATE III.

A cast of TROCHOCERAS, from the Schoharie grit, preserves the impressions of two individuals of a species of CRANIA, which were apparently adhering to the interior of the shell of the outer chamber of this cephalopod.

VENTRAL valve subquadrate, approaching a circular form; lateral margins slightly curved, and the two extremities abruptly rounded, the posterior one least curved: margins thickened. The impressions of the anterior muscles are nearly united in a transversely subelliptical scar: posterior adductor scars distant, not well defined in the specimens.

No other specimens of this or any other species of the genus are known to me, at this time, from this formation.

Geological formation and locality. In the Schoharie grit, in the town of Knox, Albany county.

CRANIÆ OF THE HAMILTON GROUP.

Crania hamiltoniæ.

PLATE III.

Crania hamiltoniæ: HALL, Thirteenth Report on the State Cabinet, p. 77; and f. 4 & 5, p. 76.

SHELL broadly oval or subcircular. Dorsal valve subconical; apex subcentral or excentric, pointed in well-preserved specimens, often worn or decorticated. Exterior surface of dorsal valve marked by concentric lamellose striæ. Ventral or lower valve marked by four strong impressions of the adductor muscles, which are variable in form: the posterior ones are distant; the anterior ones approximate, diverging above and assuming a somewhat cordiform appearance, the pit for the protractor muscles occupying the space between. Vascular impressions strongly digitate.

This species is found adhering to valves of *Athyris*, *Tropidoleptus*, *Strophodonta*, *Spirifer*, *Avicula*, *Orthoceras*, etc., and separated valves are also free in the shales. The form of the shell is very much influenced by the form of the body to which it adheres. The dorsal valve is often regularly oval and symmetrical, rising to a low subconical form, with the apex excentric on the posterior side. Some specimens are irregularly subcircular, with the surface wrinkled and uneven.

In a single specimen adhering to a Tropidoleptus, the form of the plications of that shell are carried into the dorsal valve of the Crania, conforming in part to the curvature of its margin as the shell increased in size. The form of the ventral valve is influenced not only by the contour of the body to which it adheres, but by the small bodies growing upon the same surface. In a single example, the central portion of the posterior margin is produced in a narrow extension between two Spirorbides, which prevented the shell from growing in that direction.

The dorsal valves are not unfrequently partially covered by an adhering *Aulopora*-like body; and the small *Spirorbis angulatus* is likewise found adhering to them.

In some of the specimens, the form and character of the interior of the ventral valve resembles that of the *C. obsoleta* of Goldfuss, from the Eifel, which is of Devonian age.

Geological formation and locality. In the shales of the Hamilton group, in the region of Canandaigua lake and on the shores of Seneca lake; at Bethany and Covington, Genesee county; Richmond and Bristol, Ontario county; and in Erie county. Likewise at Cazenovia and Hamilton in Madison county, and elsewhere in New-York, as well as in the Hamilton group in Maryland and Virginia.

Crania crenistriata.

PLATE III.

Crania crenistriata : Hall, Thirteenth Report on the State Cabinet, p. 78.

Dorsal or upper valve very depressed-conical, subcircular; apex central or subcentral, a little inclined.

Surface marked by sharp elevated crenulate striæ, reaching almost to the apex (which is quite smooth), and increasing by interstitial additions.

This species is rare, and four specimens only of the dorsal valve are known at this time. The character of the striæ gives the fossil, when partially obscured by

adhering shale, the appearance of the exterior of the small funnelshaped fronds of FENESTELLA. The striæ are similar to those of *Crania* (*Pseudocrania*) *divaricata* of M'COY, a Silurian fossil; but the form and position of apex is very distinctive.

The ventral valve of this species has not yet been discovered, unless it may occur among the imperfect and obscure specimens which have been referred to *C. hamiltoniæ*.

Geological formation and locality. In shales of the Hamilton group: Alexander in Genesee county; on the shore of Canandaigua lake in Ontario county; and at Eighteen-mile creek on Lake Erie, N.Y.

Crania gregaria (n. s.).

PLATE III.

SHELL small, obliquely very depressed-conical, subcircular or oblate, narrower at the posterior end; apex at the posterior third of the shell. SURFACE apparently smooth.

This small species occurs from the size of a pin's head, to those having a transverse diameter of a little more than a tenth of an inch, with a longitudinal diameter a little less than one-tenth of an inch. On a single valve of a large bivalve shell, nearly forty individuals of this species can be seen, together with the remains of several ventral valves of one of the larger species.

It may be possible that these small fossils are the young of *C. hamiltoniæ*, which have commenced their existence upon the same body which sustained the parent shells.

Geological formation and locality. In the shales of the Hamilton group, in Bristol, Ontario county.

CRANIÆ OF THE CHEMUNG GROUP.

Crania Iconi.

PLATE III.

Crania Iconi : HALL, Thirteenth Report on the State Cabinet, 1860, p. 78.

SHELL subcircular, transverse or slightly elongate. Dorsal valve convex. Ventral valve concave, variable in form, more abruptly recurved towards the margin. Hinge-line straight, equal to a little more than one-third the greatest width of the shell. Muscular impressions of the posterior adductors in the dorsal valve near the cardinal angles; the anterior ones near together and a little behind the centre, with two minute impressions a little anterior to the centre, marking the place of the retractor muscles. Ventral valve with the posterior adductors corresponding to those of the dorsal valve; the anterior adductors occupying a subcircular area, and barely separated by an elevation marking the place of the protractor muscle.

This species is known only in the condition of casts of the interior. The dorsal side is moderately convex; the apex apparently a little excentric on the posterior side.

A single cast of a dorsal valve among the specimens is more regularly elliptical, a little more convex, and without the straight hinge-line: this one may perhaps be a distinct species.

There are, likewise, in the rocks of the Chemung group, some other specimens of the character of CRANIA; but, unfortunately, I have at this time no specimens in a condition to admit of their being satisfactorily described.

Geological formation and locality. In the Chemung group: Leon, Cattaraugus county, N.Y.

Genus Pholidops (Hall).

All the known species of this genus are small shells, usually occurring as single scale-like valves or discs, and in two instances only have I seen specimens with the valves conjoined. The specimens appear not unlike the dorsal valves of a small species of Discina; but being calcareous, they have not the corneous lustre of those shells; and when conjoined, there is no evidence of a foramen in either valve. The interior shows a strong muscular callosity, and the casts bear a strongly marked impression of the same.

Pholidops arcolata (n. s.).

PLATE III.

Shell broadly subovate or scarcely circular, wider on the posterior third, broadly rounded behind and more narrowly rounded in front.

The cast of one valve (the dorsal valve?) shows a deep ovate or subcordiform muscular scar, which is nearly surrounded by an elevated areola, and partially divided by a median ridge from above. The opposite (ventral?) valve has a larger muscular scar, which is auriculate above, with the surrounding areola divided at the lower or anterior margin. Surface somewhat abruptly flattened on the posterior side, and more gently sloping on the front of the valve.

One specimen has a length a little less than one-fourth of an inch, with a width across the middle nearly the same. The only specimens known in the Schoharie grit are casts, and we have not therefore seen the exterior of the shell. In casts of two individuals, the muscular impressions present some differences in form, and in the depth of the impressions of the parts, probably indicating the characters of dorsal and ventral valves.

This species closely resembles one in the Oriskany sandstone, from which it

differs in being more ovate, as well as in the form and division of the muscular scar, and more depressed posterior side*.

Geological formation and locality. In Schoharie grit : at Clarksville and Knox, Albany county, N.Y.

Pholidops hamiltoniæ.

PLATE III.

Pholidops hamiltoniæ : HALL, Thirteenth Report on the State Cabinet, 1860, p. 92.

SHELL regularly and uniformly ovate, broader near the posterior end : apex excentric, little elevated, and slightly inclining to the posterior side.

SUBSTANCE of the shell thin, and flattened towards the margins. Surface marked by fine closely arranged lamellose striæ. Interior smooth, except an ovate, somewhat auriculate, and sometimes slightly bilobed prominence beneath the apex, which marks the muscular impression. The casts of the interior show a comparatively large muscular impression, which is shield-shaped or subovate and somewhat auriculate, or with a deeper impression on each side above the middle. In one (dorsal?) valve, the impression is a little bilobed near the lower end; and in another, which appears to be the ventral valve, there is a faint radiating or digitate impression on the lower half of the muscular scar. The surface, when magnified, shows indications of minute interrupted radiating striæ.

This species is the smallest of any described; having a length of fourteen-hundredths of an inch, with a width of twelve-hundredths in the widest part. It is not rare, but we find only separated valves.

The observations upon this genus, under the generic description, will show the facts regarding the known species, and their geological range (See Introduction to this volume).

Geological formation and locality. In the shales of the Hamilton group at Darien in Erie county, at Moscow in Livingston county, and other places in Western New-York.

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* For a description of the Oriskany sandstone species, *P. arenarius*, see Addenda to this volume.

Genus Orthis (Dalman).

ORTHIDES OF THE UPPER HELDERBERG GROUP.

There are three, or perhaps more, species of Orthis occurring in the Schoharie grit, which are the lowest beds of the group; but since the specimens are almost invariably in the condition of casts of the interior, a satisfactory determination of their specific characters is attended with many difficulties. It has been only by preserving the casts of the interior, with such impressions of the exterior surface of the shell as could be obtained, that the characteristic features of two species have been pretty well ascertained. One of these occurs in considerable numbers, while the other is extremely rare: the first resembles a species found in the limestone above the grit, but known only in few examples; while the other is quite distinct from any known above the horizon of the grit. A third species, of peculiar characters, has been seen only in a single specimen of the cast of the ventral valve; while some impressions of the exterior of a shell have not been identified with either of them.

In the limestones above the Schoharie grit we have at least five well marked species, in addition to those just mentioned.

The Orthides of this group of strata do not present any important differences, in general features, from those of the group below: they are, however, far less numerous, both as species and individuals. Two of the species are of the type of *Orthis oblata;* and two others are of the type of *O. subcarinata* of the Lower Helderberg group, while *Orthis propinqua* of the Upper Helderberg limestone resembles *Orthis multistriata* of the Upper Pentamerus limestone of the same group.

In the details of form, surface markings, area, and muscular impressions of these different species, there are sufficient means of identification, and of distinction from those before described.

Some of the species in the limestones of this group have a wide geographical distribution, but no one of them has proved to be of common

occurrence in the State of New-York. This limestone formation, within the limits of the State, being for the greater extent a firm and subcrystalline rock, has yielded few specimens of as great perfection as those of the Lower Helderberg group.

A. Species of the type of *O. elegantula* and *O. subcarinata*, with the dorsal valve nearly flat :

ORTHIS PELORIS, ORTHIS LENTICULARIS.

Orthis peloris (n. s.).

PLATE IV.

SHELL plano-convex; the dorsal valve nearly flat, and subcircular or slightly transverse : ventral valve somewhat semielliptical, very convex on the umbo, the middle regularly convex and sloping to the front and sides; cardinal line equal to or greater than two-thirds the greatest width of the shell. Area of moderate height, the beak of the ventral valve extending little beyond the area line.

SURFACE marked by fine somewhat evenly bifurcating striæ, which curve towards the margins, and a few terminate on the area line of the ventral valve.

The specimens are casts of the interior, with impressions of the exterior : from these latter, casts have been taken, which have served for the description of the exterior surface of the shell.

The internal cast of the ventral valve is highly convex; the greatest convexity being above the centre, sloping gently to the front and more abruptly to the sides. The muscular impression is comparatively small, subelliptical in form, the longitudinal being a little greater than the transverse diameter, deeply bilobed by the callosity of the adductor muscle, and the sides somewhat distinctly lobed in about three divisions. The surface of the cast, below the muscular impression, is faintly marked by the vascular impression, and the margin strongly striated. The distance from the beak, or filling of the rostral cavity, to the lower side of the muscular impression, is less than half the length of the cast.

The cast of the dorsal valve is nearly flat, with an oval muscular area which is deeply divided in the centre from the pit made by the cardinal process and its extension along the interior of the shell, whence it becomes bifurcate. The muscular impression is transversely divided by a ridge, extending on each side from the median line, as in species of the type of *Orthis elegantula*.

The casts of these two valves, which I have placed under one designation, have not been found in actual connexion; but the character of the ventral valve requires a dorsal valve of the form described, and *vice versa;* while the two occurring in the same locality, and of equal rarity, I can feel little hesitation in considering them of the same species.

Geological formation and locality. In the Schoharie grit : at Clarksville and Knox, Albany county, N.Y.

Orthis lenticularis.

PLATE V.

Orthis lenticularis [?] Vanuxem, Geological Report Third District p. 139, f. 4.
Compare *Orthis solitaria* of the Hamilton group.

Shell suborbicular or subquadrate, sometimes suboval, greatest width above or below the middle, subplanoconvex : hinge-line equalling or greater than two-thirds the greatest width of the shell; cardinal extremities rounded. Dorsal valve varying from very depressed-convex to moderately convex in the upper part, more or less abruptly depressed towards the cardinal extremities, which are a little deflected; gently curving towards the middle of the sides, and the centre marked by a sinus which begins at the beak and expands so as to produce a broad depression in front : area linear, the beak projecting a little beyond the area line. Ventral valve very convex, sometimes obtusely subcarinate along the centre; greatest convexity near, or a little above the middle of the valve, curving very abruptly to the front and to the sides (or, when carinate, it is irregularly depressed), and curving more gently towards the beak : area of moderate width, a little incurved; foramen comparatively large, wider than high; beak incurved over the foramen.

Surface finely striated with rounded subequal radiating striæ, which bifurcate at intervals, and sometimes every fifth, sixth, or seventh one is more prominent than the others : about sixteen to twenty-two striæ in the space of two lines, the striæ wider than the spaces between them, and crossed at unequal distances by subimbricating lines of growth. Entire surface finely papillose, and, on the worn surfaces, punctate.

The interior of the ventral valve preserves very strong dental lamellæ, and a strong callosity for the attachment of the cardinal muscle.

I refer this species to the *O. lenticularis* of VANUXEM with some little doubt, since the original specimen in the State Collection has been lost. The form described by Mr. VANUXEM is similar to that of figs. 1 and 2 of Plate v, which is subquadrate, the front being sometimes rounded and sometimes straight. The other forms (figs. 3, 4 and 5), which I find myself compelled to refer to the same species, are more robust, with the greatest width below the middle, and a much greater convexity of both dorsal and ventral valves.

In form, this species resembles the *O. subcarinata* of the Lower Helderberg group; but the striæ are finer, the area larger, and the muscular callosity and dental lamellæ are stronger; while the narrowing towards the hinge in the more robust forms is a character not observed in that species.

The specimens ordinarily seen have a length and breadth of a little more or less than half an inch, with a depth of about one quarter of an inch; while the largest specimens have a length and breadth of three-fourths of an inch, with a depth of about half an inch.

Geological formation and locality. In the Corniferous limestone of the Upper Helderberg group : at Leroy, Genesee county; near Caledonia, Livingston county; two miles south of Vienna, and at Shortsville, Ontario county, N.Y.

B. Species of the type of *Orthis hybrida* and *O. oblata*, with the dorsal valve more convex than the ventral :

ORTHIS ALSUS,
ORTHIS MITIS,
ORTHIS LIVIA,
ORTHIS (sp. ?),
ORTHIS VANUXEMI?
ORTHIS SEMELE,
ORTHIS CLEOBIS.

Orthis alsus (n. s.).

PLATE IV.

SHELL somewhat semielliptical in outline : cardinal line equal to, or more than two-thirds the greatest width, which is near or just below the middle. Dorsal valve more convex than the ventral, the greatest convexity being about the middle, sloping almost equally to the sides and front, and less rapidly to the beak, while it is flattened or concave towards the cardinal angles. The centre is marked by a sinus from the

beak, which gradually expands to the base of the shell. Ventral valve depressed-convex, and nearly flat in the middle of the lower half: beak small and neatly defined, projecting slightly beyond the area-line; area narrow sublinear, a little inclined; foramen partially filled by the strong cardinal process of the opposite valve. Area of the dorsal valve comparatively large, equal to two-thirds the width of the area of the ventral valve, flat or lying in the plane of the margins of the valve.

Surface marked by fine, somewhat unequal, bifurcating striæ, about eight or nine in one-fifth of an inch, much curved on the upper lateral margins.

The casts of this species are of the character of *O. oblata* of the Lower Helderberg, and others in the Hamilton group; but the hinge-line and area are much more extended, distinguishing this species from any in those strata with similar muscular impressions.

The cast of the dorsal valve, when the impression of the area is not preserved, is not readily distinguishable from some of those mentioned; though in well-preserved specimens, the depression down the centre, and also across the middle of the muscular impression, is more strongly marked than in those species.

The muscular impression of the ventral valve is proportionally small, being usually less than half the length of the valve; but it is almost always strongly defined, which, with the long hinge-line, are marked features.

This species occurs in the Schoharie grit in the condition of casts of the interior, with impressions of the exterior surface, usually as separated valves, and rarely with the impression of both valves in their natural relation. From one of these specimens, a cast in sulphur has given the exterior form and proportions of the fossil, as well as the surface markings; and a single dorsal valve, retaining the shell, has been found among the entire collection from this rock.

Geological formation and locality. In the Schoharie grit: at Clarksville, Knox, and other places in the Helderberg mountains in Albany county, and also in Schoharie.

Orthis mitis (n. s.).

PLATE V.

Shell suborbicular, of moderate convexity; area about half the width of the shell; length and width about as four to five; cardinal extremities rounded. Surface somewhat coarsely striated.

The cast of the ventral valve is depressed-convex above, depressed along the centre below, with a median groove from the adductor scar nearly to the front of the shell. Muscular impression elliptical, occupying less than half the length of the valve, and about one-third the width: lower half of valve marked by strong vascular impressions.

Two specimens in the State Collection, having respectively the length of about one-half and five-eighths of an inch, are referred with hesitation to this species. The cast of the ventral valve possesses characters which distinguish it from any species of which I know the interior. It is possible that these may be the young of *O. livia*, of which I do not know the interior at this time.

Geological formation and locality. In the Schoharie grit, in Albany and Schoharie counties, N.Y.

Orthis livia.

PLATE V.

Orthis livia [?] Billings, Canadian Journal of Industry, Science and Art, No. xxvii, p. 269, 1860.

A single well-preserved specimen, measuring one inch and one-tenth in length by one inch and two-tenths in width across the middle, presents the following characters:

Shell suborbicular, front and sides rounded: cardinal line and area equalling nearly half the width of the shell; cardinal extremities rounded. Dorsal valve of medium convexity, most convex above the middle, and curving gently and evenly towards the front and lower lateral margins, more abruptly sloping and scarcely concave towards the cardinal extremities; without perceptible mesial fold or depression: dorsal area small, flat or lying in the plane of the margins of the valve, about one-half as wide as the ventral area; dorsal beak projecting slightly beyond the edge of the area, but not incurved. Ventral valve moderately convex, the greatest convexity about one-third the length from the beak, flattened or depressed below, and slightly concave towards the front and sides: ventral area of moderate size, inclined backwards; ventral beak neatly defined, incurved, and projecting slightly beyond the area line.

Surface marked by fine subangular striæ, which increase by bifurcation, and are strongly curved on the upper margins : spaces between the striæ wider than the ridges, and, when exfoliated, showing finer striæ. Six to eight striæ in the distance of two lines.

This fossil presents so many characteristics of *O. livia* (loc. cit.), that I have referred it to that species; though in some respects it exhibits differences, which may indicate a doubt of its identity. The dorsal valve, which appears to retain its normal form, has its greatest convexity above the middle, and the ventral valve is more depressed towards the front; but these are characters which I conceive may be subject to variation, without indicating specific differences. In the specimen described, the ventral valve has been accidentally compressed.

Compared with *O. vanuxemi*, the dorsal valve is not so convex; nor does it show a mesial sinus so common in that species, while the beak is shorter, not rising so nearly to the same height as that of the ventral valve; a character common in good specimens of that shell. It differs from *O. leucosia* in the same respect, and in having the area of the dorsal valve flat; while in that species it is slightly incurved, and the form is narrow towards the beak. *Orthis penelope* is more oblate, the beaks of the two valves more nearly equal, and the striæ in this and the two other species are finer and more rounded.

The *O. livia* has been very elaborately described in the Canadian Journal, l. c.

Geological formation and locality. In the Corniferous limestone of Western New-York.

Orthis sp.?

PLATE V.

Shell orbicular or transversely subelliptical, the length and width about as six to seven : cardinal line less than half the greatest width of the shell; extremities rounded and curving outwards, the lateral margins abruptly rounded, and the basal margin broadly rounded. Dorsal valve moderately convex, somewhat flattened in the middle, the greatest convexity a little above the middle, curving regularly to the lateral and basal margins; dorsal area very narrow. Ventral valve less convex than the opposite, the greatest convexity near the beak, sloping gently towards the front and sides, becoming slightly concave towards the margins.

Surface marked by even rounded striæ, which, at intervals, show small tubular openings, while the intermediate space is minutely papillose or punctate according to the condition of the surface.

The specimen described has been a little compressed, but it appears to have possessed a broad shallow sinus on the ventral valve, very similar to *O. oblata* of the Lower Helderberg group : the striæ are stronger and more rounded than in that species.

The length of this specimen is nearly six-eighths of an inch, and its width seven-eighths of an inch; but it is probably not an adult individual, and, without more material, I hesitate to characterize it, since it belongs to a group of Orthides of which there are numerous closely allied species.

Geological formation and locality. In the Corniferous limestone of Western New-York.

Orthis vanuxemi?

PLATE V.

Orthis vanuxemi, Hall. See the same under Hamilton group.

A single specimen of a ventral valve, from the limestone, possesses characters undistinguishable from those of *O. vanuxemi*. This specimen, however, is the only one of the species which has come under my observation from the limestone. Numerous imperfect casts and exfoliated shells bear close resemblance to the species, and may prove to belong to the same.

Geological formation and locality. In the limestone of the Upper Helderberg group, near Caledonia, Livingston county, N.Y.

Orthis semele (n. s.).

PLATE V.

Some imperfect specimens showing the interior of the ventral valve, and also a small specimen of the ventral valve, possess characters approaching very nearly to *O. vanuxemi*. From the same locality there have been obtained casts of a dorsal valve, which are more elevated in the

middle, with the apex more produced than in that species. These casts give indications of a median sinus with an elevation on each side of it, and thence an abrupt slope to the cardinal extremities, and curving to the front and lower lateral margins.

In this character, they more nearly resemble the dorsal valves of *Orthis leucosia;* while the muscular impressions of the ventral valves, from the same locality, are broader than in that species. The hinge-line of a ventral valve is three-fifths the greatest width of the shell, which is greater than in either *O. vanuxemi* or *O. leucosia*, while the striæ are also much coarser. This specimen occurring with the others, while no other form of ventral valve has been seen in the same association, indicates the probable relations of the other specimens.

Although the material in my possession is too imperfect for a complete description, I have indicated the prominent features of the species, in order to call attention to the occurrence of this form in the limestones of the Upper Helderberg group.

Geological formation and locality. In the Onondaga limestone : near Clarence hollow, Erie county, N.Y. I have seen a similar form from the limestone near Columbus, Ohio.

Orthis cleobis (n. s.).

PLATE V.

Shell broadly semielliptical or subquadrate, the cardinal line being straight, and extending fully two-thirds the width of the shell; cardinal extremities rounded. Dorsal valve having a little more than the medium convexity; the greatest elevation about the centre, from which it slopes almost regularly to the beak, the front, and the lower lateral margins; while towards the cardinal angles it is more abrupt, and becomes slightly concave. Ventral valve depressed-convex above, flattened at the sides, with a broad shallow sinus which becomes deeper towards the margin.

Surface finely striated; the striæ much curved upwards at the sides.

In the cast of the dorsal valve, the distance from the beak to the lower edge of the muscular impression is about one-half the length of the valve : the area is in the plane of the lateral margins, comparatively large, having a width of

about ·18 of an inch. The cast of the ventral valve shows a large flabelliform muscular impression, from the base of which to the apex of the cast is about two-thirds the entire length, while its width is about three-fifths the width of the shell. The cicatrix for the cardinal muscle is very strong; and below it is a narrow sinus, indicating the existence of a strong median ridge. The ventral area is unknown, but it has probably been considerably larger than that of the dorsal valve.

The description is drawn from the casts of two valves, which, in some parts, preserve a little of the shell.

The long hinge-line is a characteristic feature of the shell; while the large area of the dorsal valve, and its well-marked muscular impression, distinguish it from nearly all the other species. The muscular impression of the ventral valve is remarkably large and rigidly flabelliform, with the margins strongly defined.

The casts are associated in a thin band of limestone of peculiar character, leaving no reasonable doubt of their being of the same species; while another ventral valve, referred with some doubt to this species, was likewise found in the same horizon, in the lower beds of the series.

This species, in its large muscular impression, is similar to *Orthis musculosa* of the Oriskany sandstone; but the dorsal valve is not so convex, the hinge-line is much longer and the dorsal area much larger.

Geological formation and locality. In the Onondaga limestone : near Williamsville and Clarence, Erie county, N.Y.

Orthis idas.

PLATE V.

Orthis equivalvis : Hall, Tenth Report of the Regents on the State Cabinet, 1857, p. 109.

Shell subcircular or subquadrate, the hinge-line equalling two-thirds the greatest width; sides somewhat straight; front broadly and regularly rounded, the greatest width a little below the middle. Dorsal valve moderately convex, the greatest convexity above the middle, with a shallow sinus from the beak for half the length of the shell, and curving very gently to the front and lower lateral margins, sloping a little more abruptly in the upper part, and the surface becoming concave towards the cardinal angles : dorsal area on a plane with the margins of the shell; cardinal process large and strong. Ventral valve

convex in the upper part of the centre, depressed in the middle, and concave towards the base and lower lateral margins? cardinal angles deflected : ventral area inclined backwards, of medium height; foramen wider than high; ventral beak projecting a little beyond that of the opposite valve.

Surface marked by subequal rounded radiating striæ, which bifurcate two or three times before reaching the margin. There are about ten striæ in the space of two lines near the beak, eight in the middle of the shell, and five or six near the margin. Length of specimen a little more than an inch and a half; greatest width about an inch and three-fourths.

This species is extremely rare, and I have but one good example. In this the depression of the ventral valve below the middle may be in part due to accident, and I have indicated this by an interrogation in the description. It is readily distinguished from any other species in these strata, by the long straight hinge-line and subequal valves.

In form and general aspect it resembles a Streptorhynchus, to which genus it may possibly belong, though the striæ have the character of those of an Orthis.

Geological formation and locality. In the Corniferous limestone at Williamsville, N.York.

C. Species of the type of *Orthis resupinata*, *O. multistriata*, etc., with the dorsal valve extremely convex.

Orthis propinqua.

PLATE V.

Orthis propinqua : Hall, Tenth Report on the State Cabinet, 1857, p. 110.

Shell somewhat transversely elliptical or subquadrate, the front truncate or emarginate, and the sides little curved, varying from moderately to extremely gibbous : hinge-line equalling or a little greater than half the width of the shell. Dorsal valve the larger and much the more gibbous; the greatest convexity a little above the middle of the length, curving abruptly to the sides and beak, and a little more gently to the front; sometimes a little concave just within the cardinal angles :

area inclined to the area of the opposite valve, and about one-half or two-thirds as wide; dorsal beak full, broad and rounded or obtusely pointed, extending a little beyond and slightly incurved over the area. Ventral valve less gibbous than the dorsal, very prominent on the umbo, sloping very abruptly to the cardinal angles and more gently towards the lateral and baso-lateral margins, flattened in the centre; the lower half marked by a gradually increasing, broad, and undefined sinus, which gives a strongly curved outline to the front margin: beak more acutely pointed and incurved; area elevated and incurved, its length equalling or greater than half the width of the shell. The beaks of the two valves are approximate.

Surface marked by fine unequal striæ which increase by interstitial additions, and are crossed by fine equal concentric striæ, and, at unequal intervals, by stronger imbricating lamellose lines of growth. In certain conditions of the surface, the striæ show tubular openings at the concentric lamellose lines. There are from eight to ten of the larger striæ in the space of two lines; and by counting the finer intermediate striæ, there are sometimes from thirteen to eighteen in the same space.

The cast of the dorsal valve shows a subquadrate or quadrate-ovate muscular scar, with a deeply marked border and longitudinal median groove :· a groove passes from the centre of the median line obliquely to the lower lateral angles, dividing the adductor muscular scar. The vascular impressions radiate from the muscular impression in broad bands, dividing several times before reaching the margin of the shell.

This species approaches so closely the *O. multistriata* of the Upper Pentamerus limestone of the Lower Helderberg group, that it is very difficult to distinguish them, the form and surface charactess being generally almost the same. Sometimes, however, the ventral beak and area in this species is a little more arcuate than in *O. multistriata*, and the dorsal valve is usually more gibbous, while internally they present well-marked differences. In this shell, the vascular impressions bifurcate once, twice, or even three times, before reaching the border; while in *O. multistriata*, they pass down the front without bifurcation.

The Orthis tulliensis of the Tully limestone is another form very difficult to be distinguished from this one; but it is generally more gibbous, and presents internal differences; the divisions of the vascular impressions pass down the

front of the dorsal valve nearly parallel to each other, or slightly converging; while those of the present species, as well as of *O. multistriata*, are divergent.

Geological formation and locality. Limestone of the Upper Helderberg group: New-York and Ohio.

ORTHIDES OF THE HAMILTON GROUP.

The Hamilton group, throughout the extent of its calcareous shales, is every where marked by the presence of one or more species of Orthis. The *O. vanuxemi* is the most abundant, while two allied species are of frequent occurrence. In the more eastern localities in the State of New-York these fossils are less common, and are usually in the condition of casts of the interior; affording, however, specimens not less instructive than those where the shells are entire.

In some localities in Western New-York, the prevailing species often occur in a profusion equal to the more common forms in the Lower Helderberg group in Eastern New-York.

A. Species of the type of *Orthis elegantula, Orthis perelegans*, etc., with the ventral valve nearly flat or depressed-convex.

Orthis lepidus, Orthis solitaria.

Orthis solitaria.

PLATE VI.

Orthis solitaria : Hall, Thirteenth Report on the State Cabinet, 1860, p. 60.
Compare *Orthis lenticularis*, Vanuxem, page 35, this volume.

Shell subcircular, a little transverse : valves unequally convex; hinge-line about two-thirds the greatest width of the shell. Ventral valve highly convex in the middle and above : beak small, prominent, slightly incurved; area low and well defined. Dorsal valve depressed-convex, most prominent near the umbo, with a broad shallow mesial sinus at the front, which rarely extends beyond the middle of the valve : beak small, not prominent; area linear.

Surface marked by fine radiating bifurcating striæ and strong concentric lines of growth.

At the time of describing this species, I had no authentic specimens of *Orthis lenticularis;* nor was I aware of the variety of forms which I have since obtained and examined, and referred to that species.

The *Orthis solitaria* is probably only a variety of form, or rather a greater extreme of the subquadrate forms figured on Plate V of this volume. With a single individual for examination (no other of the same having been obtained), there may remain some doubt as to the positive identity; and I have therefore permitted the description to remain, the plate having been engraved before those forms of *O. lenticularis* were collected.

Geological formation and locality. In the shales of the Hamilton group: at York, Livingston county, N.Y.

Orthis lepidus.

PLATE VI.

Orthis lepidus : HALL, Thirteenth Report on the State Cabinet, 1860, p. 78.

SHELL small, transversely subelliptical, somewhat ventricose : cardinal line little less than the greatest width of the shell; area proportionally large; beaks distant. Ventral valve very convex, regularly curved from beak to base : ventral beak prominent, pointed and slightly inclined. Dorsal valve depressed-convex, marked by a distinct mesial depression, which, in some specimens, extends nearly to the beak : dorsal beak small, pointed, but little incurved.

SURFACE marked by fine radiating striæ, which are crossed by concentric striæ and a few stronger lines of growth.

This is the smallest species of ORTHIS yet known in the Hamilton group, and is easily distinguished by the great transverse diameter, the large area, the prominent ventral beak, and the distinct dorsal sinus. It is of the type of the preceding species, but differs in its greater width, more elevated ventral beak, and larger area. The specimens observed do not exceed a quarter of an inch in width.

The species bears some resemblance to the young of *O. perelegans;* but the beak is more elevated, and the area larger. It is an extremely rare form, having been found in but a single locality and in few individuals.

Geological formation and locality. In the shales of the Hamilton group, on the shore of Canandaigua lake, Ontario county, N.Y.

B. Species of the type of *Orthis hybrida* and *Orthis oblata.*

ORTHIS VANUXEMI, ORTHIS LEUCOSIA, ORTHIS PENELOPE, ORTHIS CYCLAS.

Orthis vanuxemi.

PLATE VI.

Orthis vanuxemi : HALL, Tenth Report on the State Cabinet, 1857, p. 136.

SHELL subcircular or transversely suboval, compressed : hinge-line very short; margins of the valves crenulated within from the external striæ; interior minutely punctate. Dorsal valve convex : beak scarcely distinct from the cardinal border, not incurved; cardinal process prominent; area flat or slightly inclined to the ventral area, and about two-thirds as wide. Ventral valve nearly flat or a little concave towards the front, moderately convex in the umbonal region : beak small, extending little beyond the opposite beak, arched, and rarely incurved over the area; area very small, less than half the greatest breadth of the shell, arcuate; foramen comparatively large, triangular, and partly filled by the cardinal process of the other valve : teeth prominent.

SURFACE marked by fine, closely arranged, radiating tubular striæ, which are perforate at intervals, increasing both by implantation and bifurcation, and are crossed by very fine indistinct concentric striæ, and, at greater intervals, by more distinct, concentric, imbricating lines of growth : entire surface granulate or punctate, under a magnifier. Striæ from twelve to sixteen in the space of two lines near the beak, and from seven to nine in the same interval near the margin.

The interior of the dorsal valve shows a strong cardinal process, which is continued in a prominent rounded median ridge for half the length of the shell, where it sometimes divides, or gradually becomes obsolete : there are sometimes visible low transverse ridges, which divide the muscular impression. The crural processes are prominent, and sustained below by strong oblique ridges. In the interior of young specimens, the marks of the external striæ are visible nearly or quite to the muscular impression; while in older specimens these marks extend little beyond the margin.

The interior of the ventral valve is marked by a large flabelliform muscular impression, which reaches from one-half to two-thirds the length of the shell. The central or adductor impression is sometimes simple, and sometimes longitudinally divided by a slight median ridge which is stronger below. In the older shells, the ovarian spaces are pustulose. The dental lamellæ are strong and divergent, supported below by the ridge which margins the muscular impression. Vascular impressions are rarely seen, extending beyond the muscular area. Under a lens, the interior surface is distinctly punctate. In all well preserved specimens, the exterior shows minute tubular openings in the striæ; and when the striæ are much worn, these also are seen to be tubular; while a farther wearing of the surface shows more distinctly the minutely punctate character of the shell.

This species resembles the figures of *O. michilini* of LAVEILLE; but, compared with European specimens thus labelled, it presents many points of difference.

The *O. vanuxemi* is the most common and abundant species in the Hamilton group. The largest specimens have a length of about one inch and one-eighth, with a width of an inch and a quarter.

Geological formation and locality. In the calcareous and arenaceous shales of the Hamilton group, in Central and Western New-York. Among the best localities, are the shores of Cayuga, Seneca and Canandaigua lakes; Moscow; Darien, and Eighteen-mile creek; ranging through nearly the entire thickness of the group. In the more arenaceous shales farther east, it is common in the form of casts. It has been recognized in Maryland and Virginia; and specimens from Iowa have not been proved distinct from this species.

Orthis leucosia.

PLATE VI.

Orthis leucosia : HALL, Thirteenth Report on the State Cabinet, 1860, p. 80.

SHELL broadly ovate, greatest width below the middle, somewhat obtusely pointed at the beak; cardinal area short and small, being less than half the width of the shell : beaks approximate. Dorsal valve much the more gibbous, the greatest convexity above the middle, longitudinally marked by a median depression which is sometimes obsolete;

area scarcely more than half as wide as the ventral area, slightly inclined inwards. Ventral valve gibbous towards the umbo, depressed-convex in the centre and flattened towards the front; the front margin straight, or without sinus; area less than a line in width; foramen very broad, nearly twice as wide as high; beak slightly incurved and neatly pointed.

Surface marked by fine, radiating, bifurcating striæ, which are crossed by finer concentric striæ, and by more distant subimbricating lamellose lines of growth. Minute tubular openings are observed upon the surface of the striæ in nearly all conditions of preservation, sometimes giving a subimbricated appearance to the lines. Besides these, well preserved specimens show minute pores or puncta, distinct from the punctate structure of the shell; while the shell about the margins of these appears to have been extended, to form slender seta, the bases of which are sometimes preserved. In weathered specimens, or in those where the striæ have been partially dissolved by the decomposition of iron pyrites, these characters do not appear.

The interior of the dorsal valve shows a prominent cardinal process, which is continued in a strong median ridge for about half the length of the valve, below which are sometimes seen a few vascular markings. The impressions of the adductor muscles are, rarely, faintly separated by a transverse undefined elevation.

The muscular imprint in the ventral valve, which extends for two-thirds or more of its length, is somewhat broadly oval, flabellate, and deeply marked by the adductor muscular scar. The external striæ usually mark the inner margins of the valves, and, in young shells or thin specimens, are visible as far as the muscular impression.

This species is closely allied to the *O. vanuxemi*, and may perhaps prove only a variety of that species. In authentic specimens the shape is more ovate, the cardinal extremities less rounded, and the sides sloping almost directly to near the middle of the shell; the dorsal valve is more gibbous, and the umbo and area are more inclined inwards, as may be seen by comparing the profiles of figs. 3 *e* and 3 *k*, Plate vi, with a corresponding figure 3 *e* on Plate vii. The ventral

valve is also more gibbous, and the separated valves are conspicuously deeper than in *O. vanuxemi*.

This form is comparatively rare, occurring in few localities and having a limited range, while the other has a wide geographical and great vertical range. In one locality, great numbers of this species have been found limited to a vertical range of a few inches; while the other species occurs in the beds above and below at the same place, with scarcely an individual mingled among these.

Geological formation and locality. In the shales of the Hamilton group, at Eighteen-mile creek, Erie county; on the shores of Canandaigua lake, Ontario county, New-York; and Cumberland, Maryland.

Orthis penelope.

PLATE VI.

Orthis penelope : HALL, Thirteenth Report on the State Cabinet, 1860, p. 79.

SHELL large, oblate, proportions of length and breadth usually as four to five, plano-convex; hinge-line about two-fifths the width of the shell; cardinal extremities regularly rounded. Dorsal valve regularly convex, the greatest convexity about the centre, with a very slight mesial depression or flattening along the centre : beak small, rising but little beyond the general outline of the shell; area little more than half as wide as the ventral area, not incurved, and lying nearly in a plane with the anterior margin of the valve. Ventral valve depressed-convex above, sometimes a little gibbous towards the umbo, flat or often concave in the middle and below, the front without sinuosity : area in the larger specimens nearly one-eighth of an inch in width; foramen broad, twice as wide as high, and nearly filled by the strong cardinal process of the opposite valve; ventral beak obtusely pointed and scarcely incurved.

SURFACE marked by fine radiating bifurcating striæ, which are strongly arched upwards near the cardinal extremities, and crossed by fine pointed [illegible] lines, giving a slightly rugose appearance in well-preserved half the width; beside these are closely arranged lamellose lines of the more gibbous, ing striæ have often the appearance of being broken nally marked by a li-

or interrupted, from the peculiar manner in which the pores open upon the surface.

Interior of the ventral valve marked by a subcircular or broadly ovate flabellate muscular impression, which occupies more than half the length and breadth of the valve, and, in old specimens, is extremely thickened from its anterior margin nearly to the border of the palleal impression; the ovarian spaces distinctly pitted, pustulose or rugose, in curving ridges. Dental lamellæ strong and prominent, merging below into the raised border of the muscular impression.

Interior of the dorsal valve showing a strong prominent cardinal process, which is continued in a median ridge sometimes nearly to the front of the shell. In some specimens, low transverse ridges separate the adductor muscular scars; while in other specimens, and particularly the older ones, this division is scarcely distinct, and the muscular impression is broadly oval, with its lower margins showing foliate impressions as in the muscular impression of the ventral valve.

This species reaches a larger size than *O. vanuxemi;* often measuring more than one inch and three quarters in transverse diameter, while the largest specimens of *O. vanuxemi* seldom measure more than one inch. It differs also in the character and strength of the radiating striæ; the muscular imprint in the ventral valve is usually broader and more strongly marked; the cardinal and brachial processes of the dorsal valve are stronger, and directed towards the opposite valve; while these, in *O. vanuxemi*, are inclined forwards, or into the cavity of the shell.

In specimens of the larger and medium size, the ventral valve is quite flat or concave below the middle. The tubular character of the striæ is more strongly developed than in *O. vanuxemi* or *O. leucosia;* while in the finer punctate texture of the shell, there is no distinction perceptible. In all the authenticated specimens of this species, the cardinal line of the dorsal valve is straighter, and the beaks not approximating. The strong similarity between the three species above named will render it difficult in many cases to determine them.

Geological formation and locality. In the calcareous shales of the Hamilton group, at Eighteen-mile creek and Hamburgh, Erie county; Alexander and Pavilion, Genesee county; York and Moscow, Livingston county; and on the shores of Canandaigua and Seneca lakes.

Orthis cyclas.

PLATE VII.

Orthis cyclas : HALL, Thirteenth Report on the State Cabinet, 1860, p. 78.

SHELL small, varying from subcircular to transversely subelliptical, moderately convex : beaks appressed, not distant; cardinal line rather less than one-half the greatest width of the shell. Ventral valve convex, most gibbous near the umbo : beak small, slightly incurved; area rather low. Dorsal valve the less convex, sometimes marked by a shallow depression : beak very small, slightly projecting beyond the cardinal line; area narrow.

SURFACE marked by strong sharp prominent striæ, which are both bifurcated and implanted, often appearing fasciculate near the margin of the shell.

The largest specimen of this species which I have seen is a little more than half an inch in length, and above six-tenths of an inch in width in its greatest diameter. The length of the area is about one-third of an inch. The distinguishing features of this shell are its usually nearly circular form, the sharply prominent striæ, and the comparatively great length of the cardinal line.

Geological formation and locality. In the shales of the Hamilton group at York in Livingston county; Pavilion, Genesee county; near Bellona, and on Canandaigua lake in Ontario county, N.Y.

Orthis idoneus (n. s.).

PLATE VII.

SHELL subcircular, a little wider than long, both valves convex and nearly equal in length : hinge-line a little more than one-third the greatest width of the shell; the extremities rounded into the general contour of the shell, which is a little oblate. The dorsal valve is regularly convex above the middle, with a scarcely perceptible flattening along the median line, and becoming flattened below : beak small; not incurved; area flat, about half as wide as that of the ventral valve.

Ventral valve convex near the beak, becoming broadly flattened below the middle, and sometimes (perhaps from pressure) a little concave towards the margin; front without (or with a scarcely perceptible) sinuosity; area of moderate width, a little concave, and the beak slightly incurved: the foramen is large, and nearly filled by the cardinal process of the opposite valve.

Surface marked by fine bifurcating subangular striæ, which are marked by poriform openings upon the surface, and with the intermediate space finely punctate. There are a few lamellose lines of growth in the midde of the shell, and a larger number on the margin.

This species is one of the type of *O. oblata* and *O. vanuxemi*, differing from the latter as *O. discus* does from the former. Although its measurements differ but little from *O. vanuxemi*, its expression is that of a more nearly circular shell, and it has maintained this form from its earlier stages of growth. Owing to this feature, the striæ along the hinge-line curve a little more abrupt upward.

This species differs more distinctly from *O. vanuxemi* than either *O. leucosia* or *O. penelope;* though it is not easy to point out these distinctions, or illustrate the same in figures. It is probably identical with the species described from the Corniferous limestone on page 39, and figured on Plate v, f. 5; but that one is a little distorted by pressure.

Geological formation and locality. In the Hamilton group at Moscow, and at Eighteen-mile creek on Lake Erie.

In species so similar as some of the Orthides of this and other groups, it is difficult to point out characters by which they may be distinguished. The measurements of proportions, although often valuable, will be of little use if too far relied upon; while the degree of fineness or coarseness of the striæ, or the number of striæ within a certain space, will serve to distinguish species when there is considerable difference in the strength of these features, but I do not consider that this can be relied upon in species approaching each other.

I have given below some measurements of proportions of parts, and of number of striæ, of authentic specimens of several species, for the purpose of showing the degree of variation observed. I should mention,

however, that in the measurement of striæ in the space of two lines, on some of the more finely striated species, it is scarcely possible to include the same number of striæ between the points of the compasses at any two places upon the surface.

	Species.	Length.	Width.	Depth.	Length of area.	Striæ in the space of two lines.* Near beak.	Middle.	Near front.
	ORTHIS ALSUS....	1.13	1.23	.40	.79	10/10	8/8	7/7
	" " ..	1.03	1.24	——	——	10	8	7
	ORTHIS LIVIA....	1.12	1.21	.40	.57	7/6	6/6	6
	ORTHIS IDONEUS..	1.07	1.23	.45	.55	15/15	11/11	7/7
	" " ..	.80	.96	——	.40	14/15	11/13	10/10
	ORTHIS SEMELE ..	1.24	1.40	——	.88	——	6	6
1	ORTHIS VANUXEMI,	1.03	1.10	.43	.45	16	11	8
2	" " ..	1.15	1.28	.55	.60	15/14	11/10	7/8
3	" " ..	1.18	1.23	.46	.47	12/14	9/10	7/7
4	" " ..	1.00	1.09	——	.47	16/17	13/14	8/8
5	" " ..	.88	1.03	.37	.44	11/14	10/9	6/7
1	ORTHIS PENELOPE,	1.37	1.59	——	.65	16/14	11/12	7/7
2	" " ..	1.33	1.58	——	.58	15/16	11/10	7/8
3	" " ..	1.43	1.60	——	.73	14/13	11/12	7
4	" " ..	1.15	1.36	——	.58	14/14	11/11	8/8
5	" " ..	1.17	1.39	——	——	15/15	10/11	6/7
6	" " ..	1.17	1.31	——	.54	16	13	8
1	ORTHIS LEUCOSIA,	1.02	1.04	.52	.46	11/12	10	7
2	" " ..	0.79	0.83	.40	.31	14/13	12/12	8/9
3	" " ..	0.88	0.95	.40	.37	15/12	13/11	8/8
4	" " ..	0.95	1.02	.48	.34	14/15	12/11	8/8
	ORTHIS IDAS.....	1.53	1.71	.40	1.14	10/10	8/7	5–6/5–6
1	ORTHIS LENTICULARIS,	.77	.77	.47	.54	22	——	14–16
2	" " ..	.59	.62	.28	.44	24	22/18	16/14–16
	ORTHIS PROPINQUA,	.83	.98	.62	.55	——	10	8/8
1	" "	.....				13/15†	18‡	10/10
2	" "	.....				——	16/17	——

* In these three columns, the upper figures indicate the dorsal valve, and the lower the ventral valve.

† Besides several finer intermediate ones. ‡ Counting the intermediate ones.

ORTHIS OF THE TULLY LIMESTONE.

There is a single species of Orthis, the *O. tulliensis*, which is quite characteristic of the Tully limestone. It is unknown in the Hamilton group in New-York, or in any rock below. Though of the type of *O. multistriata* and *O. propinqua*, it is usually readily distinguished from either of these in its exterior characters, but more particularly in its muscular and vascular impressions. Its geographical distribution is very restricted, so far as known. It occurs in Onondaga and probably in Madison county, and in Cayuga and Seneca counties; while it is not found on Canandaigua lake, or at any point west within the State of New-York. The *Orthis iowensis* of the Hamilton group in Iowa is a very similar and perhaps identical species, its differences being possibly due to physical causes and wide geographical separation.

Orthis tulliensis.

PLATE VII.

Orthis tulliensis : Vanuxem, Geol. Report Third District New-York, 1843, p. 163.
Compare *Orthis iowensis*, Geol. Report of Iowa, Part ii, p. 488.

Shell rotund, transverse or nearly subcircular, the length and breadth about as seven to eight or eight to nine, the depth varying from two-thirds to seven-eighths of the length; hinge-line and area a little less than two-thirds the width of the shell. Dorsal valve the larger and very gibbous, the greatest gibbosity a little above the middle, sloping very abruptly to the beak, and more broadly curving to the front and sides: front sinuate in older specimens; the area inclined towards the area of the opposite valve, and the beak distinctly incurved, extending slightly beyond the limit of the area. Ventral valve somewhat gibbose above the middle, becoming gradually depressed, and marked by a broad undefined sinus which gives a more or less curved outline to the front according to the gibbosity of the shell: area elevated and slight-

ly incurved, the beak gently incurved over the area (and, in some specimens, more incurved than is shown in the figures); the beaks of the two valves are approximating.

The surface is marked by fine equal or subequal striæ, and a few scarcely lamellose concentric lines of growth, the bifurcations of the striæ producing scarcely visible inequalities. The texture of the shell is punctate. The number of striæ in the space of two lines varies from twelve to sixteen.

The cast of the dorsal valve shows a broadly ovate muscular impression, which is slightly divided by a longitudinal depression : from the lower part of this muscular impression the vascular markings extend in a narrow band, slightly spreading and diverging below. In this respect it differs from the *O. propinqua* and *O. multistriata*, where the muscular impression is usually more quadrate, and the vascular impressions are always diverging from the muscular area and are more divided. In some of the younger specimens of *O. propinqua*, the muscular impression of the dorsal valve is more ovate than that given fig. 39, Plate v.

The muscular impression in the ventral valve of this species is narrow ovate-lanceolate, with the limits strongly defined.

Externally this species differs from *O. propinqua* in its finer and more even striæ, as well as in its external form; the greatest width in that species being below the middle, while the margin thence, towards the hinge-extremities, is more direct. In *O. tulliensis*, the greatest width is about the middle, and the outline is pretty regularly curved.

The figures on Plate vii illustrate the usual form and character of adult specimens. The younger ones are less gibbous, but they are usually in such imperfect condition that my collections have not afforded specimens fit for illustration.

Geological formation and locality. In the Tully limestone at Tully and Tinker's falls, Onondaga county, and at Ovid in Seneca county.

ORTHIDES OF THE PORTAGE AND CHEMUNG GROUPS.

In the Report on the Fourth Geological District of New-York, I described one species of ORTHIS from the Portage group, and two species from the Chemung group, and identified a third with a European species. The specimen from the Portage group consists of a partial cast, which is finely striated, resembling the surface-characters of ORTHIS; but a farther examination proves it to belong to a distinct genus : and the Portage group, therefore, has not thus far furnished to the collections any species of ORTHIS.

In the Chemung group, within the limits of this State, we know several species of this genus, which occur more commonly in beds of the lower and central parts of the formation. In the higher beds of this group, we have at this time few evidences of the occurrence of ORTHIS; while several species of PRODUCTUS and SPIRIFER are seen in the central and higher beds more frequently than in the lower part of the group.

In their geographical distribution, the larger and more conspicuous species appear to be comparatively limited, since I have not found them in the eastern prolongation of the group in Delaware county; nor have they been often found in Chautauque county. One or more of the species are common in many localities in Tioga, Chemung, Steuben and Allegany counties, and less frequent to the westward; while some smaller forms are not uncommon in the neighborhood of Leon, Randolph and Conewango in Cattaraugus county. So far as investigations have progressed, it has not been found practicable to identify the individual beds containing these fossils to the west of Cattaraugus county; and at localities still farther west, we find a different association of fossils in beds which appear to be in the same horizon.

NOTE. The investigations in the Chemung group are unfinished, and we may obtain farther information before the close of this volume. In the mean time, the necessity of printing obliges me to send the descriptions of these species to the press.

Orthis carinata.

PLATE VIII.

Orthis carinata : Hall, Geol. Report Fourth District New-York, 1843, page 267, f. 1.

Shell transverse, often much wider than long, subplano-convex: hinge-line nearly or quite equal to three-fourths the greatest width of the shell, and about equal to its length; cardinal extremities rounded. The dorsal valve is very convex or gibbous, with a deep rounded sinus in the median line, abruptly curving towards the cardinal line and somewhat more gently to the front, depressed and scarcely flattened at the cardinal extremities. Ventral valve nearly flat, or rising from the base to the umbo with little convexity: median line carinate, with a strong and defined angular ridge, front abruptly sinuate; area comparatively narrow, a little curved near the beak : foramen wide.

Surface marked by fine radiating striæ, which increase by bifurcation and interstitial additions, and are strongly curved upwards to the hinge-line : texture punctate. The specimens are mainly casts, and the lines of growth are obscure.

The cast of the dorsal valve shows a wide subquadrate muscular impression, divided by a rounded median ridge, and transversely by a low ridge on either side, after the manner of *O. elegantula* and others of that type. The socket plates are strong and very divergent, and the cardinal process is apparently triplicate : the area is narrow and flat.

The cast of the ventral valve is nearly flat on the sides, with a defined angular carina along the median line. The muscular impression is subquadrate, deeply bilobed below, and slightly lobed at the sides. The dental lamellæ are strong and triangular.

In specimens which have suffered no compression, the length is about three-fourths the width; but in some individuals, the width is nearly double the length. The specimens are usually more or less distorted by pressure, and are likewise mostly in the condition of casts; so that all the characters of the species cannot be given. The dorsal valve is more convex than others of this type of Orthis, and the median sinus more strongly developed.

In many of its characters this species assimilates with the following, and it is possible that intermediate forms may connect them, though I have not at present the means of making this comparison fully.

Geological formation and locality. This species occurs in some beds of brown sandstone near Paintedpost, New-York, and has not been obtained in any other locality.

Orthis tioga (n. s.).

PLATE VIII.

Referred to *Orthis interlineata*, Sowerby, in Report on the Fourth Geological District New-York, p. 268.

Shell transverse, broadly elliptical, about two-thirds as long as wide: length of hinge-line a little greater than half the width of the shell; the extremities rounded into a general curved outline. Dorsal valve convex, the greatest elevation near or above the middle on each side of a well-marked mesial sinus; sometimes a little flattened at the sides, and regularly curving to the front. Ventral valve very gently convex, with sometimes a slight mesial elevation: area of medium width, with the beak slightly incurved; foramen wide.

Surface striated: striæ angular, often fasciculate, curving upwards on the hinge-line.

The shell is rarely preserved; but when it is seen, the striæ are angular, and every second one in the upper part of the shell, and every third or fourth one in the lower part of the shell, are stronger and more prominent: concentric striæ fine and closely arranged. In the casts, the character of the striæ is tolerably well preserved in the fasciculate arrangement, and in the curving upward at the sides and on the hinge-line; while on the margin, they are much more strongly impressed than on the middle of the cast. When the cast is preserved in fine shale or shaly sandstone, the surface is minutely punctate; and the shell, when preserved, has the same character.

The muscular impression in the dorsal valve is usually but faintly defined in the casts, which preserve the impression of a strong cardinal process, bifid at the extremity. The socket plates are strong and widely diverging, and the area is extremely narrow. In the cast of the ventral

valve, the muscular impression is subpentagonal, deeply bilobed below; the bases of the divisions rounded, and the sides slightly indented. The area is narrow, incurved in the middle, and extends about two-thirds the width of the shell.

This species resembles *Orthis carinata;* but among numerous specimens collected, none of them are more than two-thirds the length and breadth of the specimens of that species known to me. The dorsal valve is not so gibbous as in *O. carinata*, nor the sinus so well defined; while the striæ are much stronger upon the surface of the cast. Notwithstanding these differences, however, I am prepared to find specimens which may show the unity of these forms as one species.

This species occurs in the shaly sandstone and shale, and sometimes in semi-calcareous bands, near Factoryville in Tioga county, along the Cayuta creek, at Chemung-narrows, near Elmira, at Horseheads, and at Buck's quarry. It occurs also in Allegany county at Philipsburgh, and near Leon and other places in Cattaráugus county, New-York.

Orthis impressa.

PLATE VIII.

Orthis impressa : Hall, Geol. Report Fourth District New-York, 1843, page 268, and fig. 2, p. 267.
Compare *Orthis tulliensis*, Vanuxem, Geol. Report Third District, p. 55.

Shell rotund. Dorsal valve very gibbose, wider than long, sinuate in front : hinge-line about two-thirds the width of the shell. Ventral valve moderately convex at the sides, somewhat flattened on the umbo, with a broad undefined sinus which becomes deeper towards the front, the margin of the shell being sometimes abruptly incurved : area of moderate height, a little incurved at the beak.

The surface is very finely and evenly striated, and the texture of the shell is minutely punctate.

The cast of the dorsal valve shows a strong, somewhat quadrilobate muscular impression, limited by strong and widely diverging socket-plates, with the vascular impressions somewhat narrow and extending below it to the margin of the shell. The surface of the cast preserves fine even striæ. The cast of the ventral valve is broadly sinuate in the middle below, with a triangular or subovate deeply bilobed muscular impression, which is subject to considerable variation in form and proportions.

This species has many characters in common with *Orthis tulliensis;* differing chiefly in the broad flattened or depressed ventral valve, which has a broader and more defined sinus along the centre, and also a large and deeply divided muscular impression which is sometimes lobed. It is possible that these characters, which are subject to variation in the specimens before me, may be only differences caused by the conditions of life in the *O. tulliensis* at a later geological period.

The *Orthis tulliensis* occurs in the Tully limestone in the central part of the State, principally in Onondaga and Cayuga counties. It has not been found in the Hamilton group; and in the thin bands of Tully limestone it is associated chiefly with *Rhynchonella subcuboides*, a fossil restricted, as far as known, to that horizon.

Between the Tully limestone and the Chemung group we find interposed the Genesee slate and Portage group, which together make a thickness of eight hundred to one thousand feet : in these beds, no species of Orthis is at present known.

The species of this type, from the *O. multistriata* of the Lower Helderberg group to this one from the Chemung group, bear many characters in common, and under some circumstances it might be difficult to distinguish them. The *O. multistriata* has subequal striæ, approaching in this character to the *O. tulliensis*, which it likewise resembles in form; but the beak of the ventral valve is more produced, and the area is less divergent from the plane of the longitudinal axis; while the dorsal area is not so high, and the sinus in front is more abrupt. These features are shown in figs. 2 *a* – 2 *i* of Plate xv, Vol. iii, Pal. N.York. In the same species, figs. 2 *k* – 2 *r*, the muscular areas are similar to those of *O. tulliensis;* that of the ventral valve being a little more strongly lobed and more angular in outline, while that of the dorsal valve is but slightly different in form. The vascular impressions proceeding from the base of the muscular area are, however, quite distinctive in all the casts seen, and may be compared in figs. 2 *l*, *o*, *p* (*loc. cit.*), with fig. 5 of Plate vii, Vol. iv, which represents the constant character of *O. tulliensis* as well as of the western form, *O. iowensis*. The differences between the *O. tulliensis* and *O. propinqua* have already been pointed out, and, in a considerable number of individuals, these characteristics are reliable; but when we find crushed and distorted specimens of the two species, they are not easily distinguished.

The Chemung specimens are never entire : they are generally distorted, and the shell is rarely preserved to any extent. In the distorted specimens, the muscular impressions of course participate in the abnormal appearance; but in several well preserved specimens of the ventral valve, there is a much greater variety of form and proportions of this part than has been observed in any one of the species before described.

Geological formation and locality. This species occurs in the shaly sandstone and semicalcareous bands of the Chemung group, at Ithaca and Cayuta creek; at Chemung-narrows, and near Elmira; also at Philipsburgh in Allegany county, and at Leon and elsewhere in Cattaraugus county.

Orthis leonensis (n. s.).

PLATE VIII.

SHELL transverse, somewhat broadly elliptical. Dorsal valve with a distinct longitudinal sinus, and having the base more or less distinctly truncate in the middle; the sides, for a little way below the beak, are sometimes straight, but usually curved. Ventral valve regularly convex in the middle and upper part, sometimes a little depressed towards the base and elevated along the median line: muscular impression oval or ovate, and sometimes visibly lobed. The area is much shorter than the width of the shell. The surface is marked by rather strong striæ, which are more or less preserved upon the cast.

The strength of the muscular markings, as well as of the striæ, vary considerably, depending on the thickness or strength of the original shell.

The species bears some resemblance to the young of *O. tioga;* but the muscular impressions are different, and the sinus in the dorsal valve is quite unlike that one. A considerable number of specimens have been found, but among them there are no large individuals, and it would appear that the species never attained a large size.

FIGS. 3, 4 & 5 of Plate VIII are illustrations of the dorsal valve.

FIGS. 6 & 7 are the ventral valves.

FIG. 8 represents the surface of a larger ventral valve which may possibly be of this species, as it occurs in the same association.

FIG. 1, *O. leonensis?* is an enlargement of a cast of the ventral valve, where the muscular impression is much stronger than usual, and the surface below is much flattened; a feature which may possibly have come from great thickening of the shell, or it may be a different species.

Geological formation and locality. In the arenaceous beds of the Chemung group, near Leon, Conewango, and Randolph in Cattaraugus county.

Orthis thiemei?

PLATE VIII.

Orthis thiemei? WHITE, Journal of the Boston Soc. Nat. History, Vol. vii, p. 231.

Among the ORTHIDES from Cattaraugus county are some casts, that bear a very close resemblance to this species of the arenaceous beds at Burlington, Iowa. The ventral valve is flattened or depressed in the middle below the muscular impression, and the sides are narrowed towards the hinge-line, which is shorter than the width of the shell.

The casts of ventral valves referred to this species occur in the same beds with *O. leonensis;* and it is not impossible that the dorsal valves like fig. 5, Plate viii, may belong to the same.

Geological formation and locality. Arenaceous beds of the Chemung group, near Leon, Napoli and New-Albion, Cattaraugus county.

Orthis leucosia?

PLATE VIII.

Compare *Orthis leucosia*, Plate vii, p. 48, this volume.

Figs. 9 and 10 are representations of the exterior of the shell of a dorsal valve, and the cast of a ventral valve, which occur in a specimen of olive shaly sandstone, labelled as from Steuben county. The specimen contains, besides these, the impression of a PRODUCTUS and of LEIORHYNCHUS, giving the character and aspect of the Chemung rocks; but it is the only specimen in which this ORTHIS has been observed, and it seems to me possible that it may have been derived from some of the higher and more arenaceous beds of the Hamilton group in the eastern part of the State, where the lithological characters of the two formations are very similar.

Genus Streptorhynchus (King).

The Genus Streptorhynchus was published in 1850 by Prof. King, to include some peculiar forms of strophomenoid shells; one conspicuous character of which is that the umbone of the larger valve is irregularly twisted. The genus possesses features somewhat intermediate to Orthis and Strophomena; and for want of a full understanding of these characters, the species have been referred, first by Davidson, and after him by other authors, to the Genus Orthisina. Regarding the twisted or distorted beak as one of the essential features of the genus, there are regular forms having internal characters corresponding with the typical species of the genus, which on the one side have been forced among the Orthis, while others have been placed among Strophomena.

As at present constituted, the genus will include such forms as I have described in the third volume (Pal. New-York) under the names *Strophomena woolworthana* and *S. radiata*, which are probably identical species. Going back to the Niagara form *S. subplana*, we find that it also may be included under the Genus Streptorhynchus; and among the Lower Silurian forms, *Strophomena recta*, *S. deflecta*, *S. filitexta*,* and some others, may be included in the same group; these latter showing the lowest indications of those features of the hinge-structure which are more strongly developed in the species of later geological periods.

The shells of this genus are semicircular or semielliptical, concavo-convex or plano-convex, and sometimes with both valves convex: they are externally striated with rounded bifurcating threadlike striæ, which are crossed by fine concentric lines; and in some forms the stronger striæ are distant, with finer radiating and concentric striæ cancellating the intermediate spaces. The ventral beak is sometimes produced and bent or twisted, and the fissure beneath the beak is closed or partially closed by a solid deltidium, while the area is subject to great variation. A narrow area often exists on the dorsal valve, but this is not a constant character.

* See Sixteenth Report on the State Cabinet, 1863.

I shall endeavor to show, in another place, that the species now referred to this genus may be arranged in three natural groups, though it may be questioned whether this limitation can always be determined by the exterior characters of specimens.

In the Report on the Fourth Geological District (1843, p. 266), I described, under the Genus STROPHOMENA, three species (*S. bifurcata, S. arctostriata* and *S. pectinacea*) which now prove to belong to the Genus STREPTORHYNCHUS. These determinations and descriptions were made from few specimens, but the characters were unlike, and were deemed sufficiently constant to entitle them to specific distinction. Larger collections of specimens have enabled me to make more extensive comparisons, and I am now convinced that these forms graduate into each other, and even take a much wider range than was exhibited in the specimens illustrated. I am moreover satisfied that the *Strophomena chemungensis* of CONRAD is a STREPTORHYNCHUS, and specifically identical with those just enumerated, having precedence in point of time.

In the Tenth Report on the State Cabinet (1857), I described *Orthis perversa*, which belongs to the Genus STREPTORHYNCHUS; and in the Report for 1860, I described *Orthisina arctostriata* and *O. alternata*, both of which are of the Genus STREPTORHYNCHUS. In the same year, Mr. BILLINGS described the *Streptorhynchus pandora* of the Corniferous limestone; an appropriate name, perhaps, when we reflect that this is but another form of a species to which all those just mentioned must be referred.

More extensive collections have shown that it is quite impossible to accumulate any considerable number of specimens of any one of these types, without encountering variations which lead to other forms lying intermediate to that one and the other most nearly allied form, until finally it becomes impracticable to draw lines of specific distinction between them.

To begin with the oldest form at present included in this group, the *S. pandora*, which occurs in the Schoharie grit and Corniferous limestone, we have usually, but not always, a symmetrical form, differing but little (if at all) from *S. woolworthana* of the Lower Helderberg group. We are able to trace this form in the Hamilton group, where, although rarely

attaining the dimensions which it has in the limestone below, it possesses nevertheless all the essential characters of that one in its symmetrical form, and can also be traced into the unsymmetrical forms where the area is unequal and the beak distorted, but where no two individuals are precisely alike. From these unsymmetrical forms which I have termed *S.* (*Orthisina*) *arctostriata*, to those where the striæ are more unequal, the gradation is imperceptible; and the *S.* (*O.*) *alternata*, in its typical form, is not more abundant than are the intermediate varieties.

In the Chemung group, we have a much greater degree of variation among those which I have referred to the same species. The symmetrical forms, like *S. pandora* of the Corniferous limestone, can be traced everywhere; and in the arenaceous beds, they sometimes so much resemble those of the Schoharie grit, that specimens laid together might not be readily separated. We find among these a greater or less degree of prominence in the muscular impressions, or of the ridge dividing the muscular impressions, and also of the cardinal process, which may have a greater or less extension, and the small ridge between the two branches of this process may be prominent or otherwise. From these forms there is a very simple gradation to such as *S. bifurcatus*, where the striæ are a little stronger and more regularly bifurcating: these are often nearly, but rarely quite, symmetrical. The type of *S. pectinacea* is readily reached by a partial suppression of some of the striæ and a greater development of others; leaving the larger and more prominent ones with two, three or more smaller ones between them.

Such forms as *S. arctostriatus* have the striæ nearly equal, and quite thin and sharply prominent; but even in these there are finer intermediate striæ, but the interspaces are so nearly equal that the surface presents a pretty uniform aspect, though there are many gradations. Specimens of this kind have usually broad convex dorsal valves, which are sometimes depressed in the centre.

In the form of *S. pectinacea*, we have a near approach to the *Orthis inequalis* of the sandstones beneath the Burlington limestone in Iowa and elsewhere. The Burlington specimens are usually very symmetrical; but

the general form, and the alternation of coarser and finer striæ, correspond very nearly with the specimens in the Chemung group of New-York; and with the materials before me, I can find no specific distinction.

The variety of forms heretofore described as species have been studied at different times and under different circumstances; and it has only been after the entire series from the successive formations were brought together, with large accessions of individuals, that their true relations could be established.

Two other species of STREPTORHYNCHUS have been described from the sandstone of Burlington, Iowa. One of these, in a single specimen examined, presents some marked differences; but having no extensive collections from that place for comparison, I do not know what variation either of them may present on farther examination.

Streptorhynchus chemungensis.

PLATES IV, IX & X.

Strophomena chemungensis : CONRAD, Jour. Acad. Nat. Sciences, Vol, viii, pa. 357; pl. 14, f. 12. 1843.
Strophomena bifurcata : HALL, Geol. Rep. 4th Dist. New-York, p. 266, f. 2. 1843.
Strophomena arctostriata : HALL, Ibidem, p. 266, f. 3. 1842.
Strophomena pectinacea : HALL, Ibidem, p. 266, f. 4. 1842.
Orthis perversa : HALL, Tenth Report on the State Cabinet, p. 97. 1847.
Streptorhynchus pandora : BILLINGS, Canadian Journal, [N.S.], No. xxvii, p. 226. 1860.
" " BILLINGS, Geology of Canada, p. 369. 1863.
Orthisina arctostriata : HALL, Thirteenth Report on the State Cabinet, p. 80. 1860.
Orthisina alternata : HALL, Ibidem, p. 81. 1860.
Orthis inequalis and *Orthis pravus* : HALL, Geol. Report of Iowa, Part ii, pa. 49, pl. 2, f. 6.

The following is the description of the species given by Mr. CONRAD :

" Semiorbicular. Inferior valve ventricose : superior valve slightly con-
" cave, with a prominent umbo; radii very numerous, prominent, sub-
" equal; umbo of inferior valve ventricose, summit not prominent;
" hinge-angles nearly rectangular; margins extending in a very regular
" curve from the cardinal extremities.

" LOCALITY : Chemung-narrows, New-York. Devonian."

This description is applicable to many of the specimens of the Chemung group, but the figure given is proportionally longer than those among my collections. There is, however, no other species in the Chemung group to which the description applies.

Var. A. Streptorhynchus pandora.

PLATES IV & IX.

Streptorhynchus pandora : Billings, Canadian Journal, p. 226. 1860.
" " Billings, Geology of Canada, p. 369. 1863.
Compare *Streptorhynchus* [*Strophomena*] *woolworthana*, Hall, Tenth Report State Cabinet, p. 8. 1857.
" " " " Hall, Pal. New York, Vol. iii, pa. 192, pl. 16, f. 1 & 2. 1859.

This shell, in its symmetrical form is somewhat semioval, the length and width being about as four to five. A well-formed specimen, of one inch in length, measures one and a quarter inches in width : hinge-line equal to the greatest width of the shell, and forming right angles with the sides, which are usually nearly straight; the front broadly rounded : cardinal extremities sometimes a little salient, and sometimes rounded. Ventral valve convex on the umbo, the greatest convexity being at the apex, from which the surface slopes in a regular plane to the sides and middle of the shell, becoming slightly concave below the middle and along the front : area large triangular, extending the entire length of the hinge-line, and inclining over the dorsal valve at an angle of about 110°. The foramen has been large, about twice as wide at the base as the height, and is closed by a convex deltidium. Dorsal valve moderately convex, a little flattened towards the cardinal extremities, and curving towards the sides and front; area narrow and linear.

Surface striated by numerous fine strongly elevated striæ, which are increased by bifurcation and interstitial additions, and crenulated by fine closely arranged concentric striæ.

The interior of the ventral valve is marked by strong dental lamellæ and a broad flabellate muscular impression, which, in well-preserved specimens, shows the cordiform imprint of the adductors, and a short low mesial septum in the upper part.

The interior of the dorsal valve preserves deep dental sockets, with thick socket-plates which support the duplicate cardinal process, each division of which is grooved at the extremity. There is likewise a small

process between the two branches of the cardinal process; and below the hinge-line, the flabelliform muscular impression is divided by a low rounded mesial longitudinal ridge or obsolete septum.

The ordinary size of specimens, in the Corniferous limestone, is about one inch in length by one and a quarter inches in width; while others measure one inch and an eighth in length, by an inch and a half in width. The largest individual observed is a cast in Schoharie grit, which measures nearly two inches in width.

I have referred this species to the *S. pandora* of Billings, with which it corresponds in general form and character; though the author remarks that "Our "shell closely resembles *S. crenistria* in external form, but differs in not having "the radiating striæ crenulated, and further in the form of the occlusor muscular "impressions in the dorsal valve. According to Davidson's figure, there is a small "process between the two branches of the cardinal process, which does not exist "in ours."

The radiating striæ, in all this group of shells that have fallen under my observation, are crenulated by concentric striæ; and in well preserved specimens of this species, these crenulating striæ are very distinct. The median process is well preserved in our specimens, and forms one of the slight distinguishing features between it and *S. woolworthana;* though I am not disposed to regard this as a constant character, or one of specific importance.

Externally there is very little difference between the *S. woolworthana* of the Lower Helderberg, and the species under consideration in its symmetrical forms. Among the few differences observable are the slightly depressed apex of the ventral valve, giving the greatest elevation a little below that point in the Lower Helderberg species; while the area is narrower on that valve, and a little wider on the dorsal valve. The striæ are perhaps a little finer in *S. pandora*, but these characters are subject to much variation. In the interior, the muscular impression of the ventral valve of *S. woolworthana* is proportionally a little larger, and that of the dorsal valve perhaps not so distinctly defined; but this feature may vary from difference in the thickness of the shells. In the dorsal valve of *S. pandora*, the socket-plates are stronger than in the Lower Helderberg species, and are thickened about the base of the cardinal process, projecting beyond the line of the area, while the processes are not (usually) each doubly grooved as in *S. woolworthana;* and while in that one there is no median process, the Upper Helderberg species preserves that feature very distinctly, often reaching as high as the lateral divisions of the cardinal process.

Notwithstanding these slight differences, I feel disposed to recognize the two as distinct; though, adopting the line of argument which has been used in regard to the Lower and Upper Helderberg Strophodontæ*, I should be compelled to regard the *S. pandora* as identical with *S. woolworthana*. There will be found, moreover, among the species of several genera of the Brachiopoda from the Lower and Upper Helderberg formations, a like degree of similarity as I have already shown to exist between the Niagara and the Lower Helderberg species.

The conditions prevailing during the epoch of the Upper Helderberg formation were very similar to those during the Lower Helderberg, the two being separated by the Oriskany sandstone and Cauda-galli grit. There was, during the older period, a greater amount of shaly matter deposited than during the later period, which is almost wholly calcareous, and we have in the entire fauna an adaptation to these conditions.

The *S. pandora* first appears in the Schoharie grit, where it occurs in considerable numbers, although generally in the condition of casts. It has, in this part of the formation, attained a diameter of nearly two inches in some of the larger specimens. Figs. 11 – 19 of Plate IV represent its usual condition in this rock. Fig. 12 is drawn from a cast of a ventral valve, made in a natural mould in the stone. Figs. 11, 15 & 16 ar casts of the dorsal valve, while 13 & 18 are casts of the ventral valve. Fig. 14 is an artificial mould of the interior, from a cast in stone, and does not fully represent the cardinal process. Fig. 19 represents a specimen with the sides more regularly curved than usual.

The figures on Plate IX, from 18 to 25 inclusive, are of specimens from the Corniferous limestone; showing the dorsal, ventral, and profile views of a symmetrical specimen, with the interior of the two valves, hinge-line, etc.

The figs. 19 – 23 of Plate X are illustrations of the casts of symmetrical forms from the Chemung group, and which differ in no essential degree from the *S. pandora* of the Corniferous limestone.

The casts from the Schoharie grit show stronger muscular impressions, owing to the thicker shell; while the Chemung forms, having lived among sediments containing little calcareous matter, have had a thinner shell, and consequently the muscular imprints are less conspicuous in the cast.

Geological formation and locality. In the Schoharie grit at Schoharie, Knoxville, Clarksville and other places, and in the Corniferous limestone at Clarksville and Schoharie; at Eastman's quarry south of Utica; in Ontario county, and at Clarence-hollow and Williamsville in Western New-York; and in Canada West; being coextensive with the Limestone formation in this State and Canada.

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* Billings in Canadian Journal, July, 1861.

Var. B. Streptorhynchus arctostriata.

PLATE IX.

Orthisina arctostriata : HALL: Thirteenth Report on the State Cabinet, 1860.

SHELL semicircular or semielliptical, frequently unsymmetrical, the proportions of length and breadth varying in different individuals: hinge-line straight, nearly or quite equal to or greater than the greatest width of the shell; sides nearly rectangular to the hinge-line, or curving inwards. Ventral valve more or less convex towards the umbo and sometimes in the middle, curving downwards or flattened towards the front and sides of the shell: beak often distorted; area vertical or inclined forwards or backwards, usually unequal on the two sides of the foramen, which is closed by a strong convex deltidial plate. Dorsal valve depressed convex, sometimes nearly flat and sometimes very convex, with a narrow linear area: socket-plates strong, and supporting the cardinal process, which is double and has sometimes a faint ridge between the two divisions, which are themselves very short.

SURFACE marked by sharp close radiating crenulated striæ, which increase mainly by interstitial additions.

The shells which I have heretofore referred to this species are represented by individuals varying from one-fourth to three-fourths of an inch in length, and having a width of from one-fourth to one-third greater than the length.

The examination of a larger collection than I had before me when the species was first described, has shown that the convexity of the ventral valve is very variable: the extent of the area is likewise subject to much variation; and the beak is sometimes symmetrical, and varies from extreme distortion to a scarcely perceptible obliquity of the apex. In some specimens there are strong lamellose lines of growth, and in others these lines are scarcely visible. The dorsal valve varies from nearly flat to very convex; and in some specimens the length and breadth are almost equal, while the cardinal process is scarcely developed beyond the plain socket-plate, which is bent outwards, and sometimes scarcely divided at the apex. The surface striæ are, in some specimens, more rounded and pretty equally developed, while in others they are very sharp and unequal. Finally, we can trace the gradation from the unsymmetrical and distorted specimens, to those which are not distinguishable from well-marked specimens of *S. pandora* as it appears in the Schoharie grit.

These variations are illustrated on Plate IX, where figures 1 & 2 are typical forms of the species, in some of which the area is inclined forwards.

FIGS. 3, 4 & 5 are views of dorsal valves which are proportionally longer, but have a regular convexity.

FIGS. 6 & 7 are of a larger dorsal valve of similar form, but more irregular exterior.

FIGS. 8 & 9 are the dorsal and ventral valves of a slightly distorted specimen.

FIG. 10 is a ventral valve which is slightly unsymmetrical.

FIG. 11 is a symmetrical ventral valve, which has the form of area and muscular impression of *S. pandora*.

FIG. 12 is an enlarged figure from a cast in arenaceous shale. The striæ appear coarser than in the softer shale.

In a slab with numerous specimens, the apices of some are a little distorted, and others are quite symmetrical.

Geological formation and locality. This variety occurs in the Hamilton group, at York, Moscow, Pavilion, Darien, Canandaigua lake, and Bristol, Ontario county; and near Tully, Onondaga county.

Var. C. Streptorhynchus perversa.

PLATE IX.

Orthis perversa : HALL, Tenth Report on the State Cabinet, 1857, p. 97.
Orthisina alternata : HALL, Thirteenth Report on the State Cabinet, 1860.

SHELL subelliptical, wider than long; the cardinal extremities rounded, and the hinge-line less than the width of the shell. Length and width about as two to three; the sides curving shortly, and the front broadly rounded. The ventral valve is very convex at the umbo and the beak distorted, somewhat depressed below the umbo, and nearly flat or unequally depressed-convex on the middle and lower part : area nearly vertical, with the apex inclined or arcuate; foramen closed by a prominent convex pseudo-deltidium. Dorsal valve rounded, convex or sometimes gibbous; the greatest convexity above the middle, and sloping abruptly to the hinge-line, sometimes flattened or a little depressed in the middle towards the front.

SURFACE marked by distant elevated striæ which increase mainly by interstitial additions, and the intermediate spaces are crossed by elevated concentric undulating striæ.

In my description of this species, I remarked that it "is of the type of *Orthis* " *umbraculum*, and presents the irregularities of form common to that shell."

The species described as *Orthisina alternata* is not distinct from this; and although without larger collections of specimens, it is impossible to draw lines of specific distinction, yet the prevailing forms may be separated into two groups; leaving a few which are not so readily referred to either of them, or which may be intermediate forms, uniting the two and likewise including *S. pandora*.

I have adopted the name *S. pandora* as applicable to the symmetrical forms of the Schoharie grit and Corniferous limestone, and some of those in the Chemung group; while the *S. arctostriata* and *S. perversa* are more characteristic of the Hamilton group.

FIGS. 13 & 14 are examples of the dorsal valves of this variety.

FIG. 15 is an irregular form of the same.

FIG. 16 is an intermediate form of the ventral valve, with the striæ intermediate in distance and the cardinal angles but little rounded,

FIG. 17 is the dorsal valve, which is quite symmetrical in form, but with distinct striæ and rounded hinge-extremities.

FIG. 26 is a very convex dorsal valve with slightly rounded cardinal extremities, and having comparatively distinct striæ. The umbo is very prominent; below which it is flattened in the middle, and slightly depressed towards the front of the shell.

Geological formation and locality. This variety occurs on Seneca and Cayuga lakes, Moscow and Hamilton, in the Hamilton group. Fig. 17 is from the same group, in the village of Fabius, Onondaga county. Fig. 26 is from the Corniferous limestone at Williamsville, Erie county. In the latter, the striæ are more nearly equal.

Var. D. Streptorhynchus pectinacea.

PLATE X.

Strophomena pectinacea and *S. bifurcata* : HALL, loc. cit.

SHELLS usually symmetrical, often unsymmetrical, semioval, with the hinge-extremities sometimes a little salient, often truncate and sometimes rounded.

The dorsal valve is moderately convex, or sometimes gibbous. The surface is marked by distant, very prominent striæ, with two or three finer ones between them. The hinge, and other features of the shell, are the same as in other varieties of the species.

The well-marked specimens are usually small or of medium size.

Among a large number, the gradations to *S. bifurcata*, where the striæ are regularly bifurcating and of nearly equal size, are almost imperceptible. It is apparently as the individuals become larger that there is an increase in the gibbosity of the dorsal valve, while at the same time the striæ become somewhat regularly alternating in size, and in some specimens nearly equal, but retaining a sharpness of outline not observed in specimens from the limestone.

It was to those specimens with sharp equal striæ and gibbous dorsal valves that I originally gave the name *Strophomena arctostriata* (Report of Fourth District). Specimens of this kind approach, both in form and expression, the figures of *Streptorhynchus crenistria*, illustrated by Mr. Davidson (Monograph of British Carboniferous Brachiopoda), where figs. 2 & 8, Plate xxvii, may be compared with figs. 8, 11 & 14 of Plate x of this volume. The British Carboniferous specimens are larger than ours of the Chemung group.

The gradations of form and character are pretty well shown on Plate x. Figs. 1 – 6 are of the smaller forms, having the prevailing surface-marking characteristic of *S. pectinacea*. The ventral valve fig. 2, and the cast of ventral and dorsal valves respectively figs. 3 & 5, are more like *S. bifurcata*.

In figs. 7 & 8 we have gibbous dorsal valves, somewhat depressed towards the front, and with the striæ subequal or alternating; and fig. 10 is the ventral valve of similar character.

In the figs. 11 – 17, we have specimens with somewhat unequally convex dorsal valves : the ventral valves are irregular towards the umbo, and the beaks more or less distorted; while the area presents much variety in its degree of elevation.

In fig. 18, we have a ventral valve with the striæ as regular and even as those from the limestone; and in the casts, figs. 19 – 23, we have symmetrical forms with even striæ, and with form of muscular impression undistinguishable from those of the Schoharie grit, the only distinctive feature in those from the Chemung group being the tenuity of the shell.

The varieties illustrated on Plate x are common and often abundant in the Chemung group, having a considerable vertical range, and in horizontal range are almost coextensive with the formation within the limits of the State. They are most abundant and present greatest variety of form in Chemung, Allegany and Cattaraugus counties.

Following the comparison of the New-York Chemung species with similar forms of the Waverly sandstone* of Ohio (which I have regarded as of the same age),

* The term "*subcarboniferous*" has been applied by some authors to these sandstones. This is a very pernicious nomenclature, as the term is equally applicable to all rocks below the Carboniferous period.

I am unable to find any characters by which the specimens from the two localities may be separated into distinct species or even marked varieties. In my collections from Ohio, the specimens of STREPTORHYNCHUS are comparatively less common than in similar collections made in the Chemung group of New-York. In the rock still farther to the west, the sandstones of the "Knobs" near New-Albany, I find a STREPTORHYNCHUS of similar form and proportions, varying chiefly in the more distinct crenulation of the striæ. This feature, however, appears to me oftener due to the nature of the matrix in which the fossil is imbedded, than to any original difference in the shell itself.

Whether these forms can be traced into the large species of the upper sandstones of the Knobs and of the Keokuk formation (*Orthis keokuk*, which Mr. DAVIDSON has identified with *Streptorhynchus* (*Orthis*) *crenistria* of Europe), remains still undetermined. My collection does not furnish intermediate forms sufficient to justify such a conclusion at the present time.

The large specimens from the higher part of the sandstone and the concretionary bands of limestone near New-Albany have always a thin median septum in the ventral valve, extending from the apex more than one-third the length of the shell. The cardinal process of the dorsal valve has, moreover, at its base, on one side, a short vertical ridge; while between these, and immediately below the process, the valve is a little thickened on the inner side. The dental sockets are nearly filled up, leaving a thin accessory ridge on each side of the cardinal process. The shells have been so thin that the casts show very little muscular marking.

The illustrations of *S. crenistria* of Europe, which I have seen, do not presenl the distinct median septum in the ventral valve, which is seen in the large specimens referred to.

Specimens from the Keokuk limestone show a large muscular impression in the ventral valve, which is divided by a longitudinal septum reaching to the base of the imprint. The same feature exists in specimens of all dimensions from the Coal measures.

Genus Strophomena (Rafinesque).

The Genus Strophomena of Rafinesque has for its type the *S. rugosa* = *S. rhomboidalis*, Wahlenberg; a species which ranges from the Lower Silurian to the base of the Carboniferous system inclusive, appearing under various aspects in the successive geological stages. The species has been already fully illustrated in the preceding volumes of this work, and it is only necessary to give the more important among the varieties of form in the succeeding formations.

Restricting the genus to such forms as may properly be grouped with the typical species, we find no species of Strophomena proper in the Devonian; and indeed it may be doubted whether any other species of this genus occurs above the Middle Silurian.

Strophomena rhomboidalis.

PLATE XII.

Dritte Anomiten art mit breiter schlosskante : Hupsch, Naturgeschichte des Niederdeutschland, 1781, Vol. i, pa. 15, pl, 1, f. 7 & 8.

Anomites rhomboidalis : Wahlenberg, Acta Soc. S. Upsaliensis, 1821, Vol. viii, pa. 65, n° 7.

Producta depressa : Sowerby, Genera of Shells; & Min Conchology, 1825, Vol. v, pa. 86, pl. 459, f. 3.

Producta depressa : Hisinger, Vet. Acad. Handlingar, 1826, p. 33.

Productus depressus : Defrance, Dict. des Sciences naturelles, 1826, Vol. xlvii, p. 353.

Leptæna rugosa : Dalman, Vet. Acad. Handlingar, 1827, pa. 106, pl. 1, f. 1.

Leptæna depressa : Id. Ib., pa. 107, pl. 1, f. 2.

Strophomena rugosa : Bronn, Leth. geognostica, 1835, Vol. 1, pa. 87, pl. 2, f. 8.

Producta depressa : Phillips, Geol. Yorkshire, 1836, Vol. ii, pa. 215, pl. 8, f. 18.

Productus depressus : Deshayes, Lamarck animaux sans vertebres, 2d edition, Vol. viii, p. 380.

Leptæna rugosa and *L. depressa* : Hisinger, Leth. Succica, 1837, pa. 69, pl. 2, f. 2 & 3.

Orthis rugosa : Von Buch, Ueber Delthyris, 1837, p. 30.

Leptæna : Fischer, Oryct. du Gouvernement du Moscou, 1837, p. 142.

Leptæna depressa : J. Sowerby, in Murchison Sil. System, 1839, pa. 623 & 636, pl. 12, f. 2.

L. tenuistriata [?] : Id. Ib., pa. 646, pl. 22, f. 2 a.

L. rugosa : Id., Trans. Geol. Soc. London, 1840, 3d series, Vol. v, pl. 56, f. 4.

Orthis rugosa : Eichwald, Sil. System in Esthland, p. 162.

Leptæna rugosa : Phillips, Pal. Fossils, 1841, pa. 57, pl. 24, f. 95.

Leptæna depressa : De Koninck, Desc. An. fossiles de Belgique, 1842, pa. 215, pl. 12, f. 3 – 6; and pl. 13, f. 6.

Leptæna depressa : G. B. Sowerby, Conch. Manual, 1842, pa. 71 & 300, f. 206.

Orthis rugosa : D'Archiac et De Verneuil, Trans. Geol. Society London, 1842, 2d series, Vol. ii, part 2, p. 396,

Strophomena depressa : Vanuxem, Geol. Report Third District New-York, 1842, pa. 79, f. 5.
S. undulata : Id. Ib., p. 139, f. 3.
S. depressa : Hall, Geol. Report Fourth District New-York, 1843, p. 77, f. 5; and p. 104, f. 2.
Orthis rugosa : F. C. Rœmer, Rhein. Uebergangsgebirge, 1844, pp. 85 & 90.
Leptæna depressa : De Verneuil, Geol. Russ. and the Ural, 1845, Vol. ii, pa. 234, pl. 15, f. 7.
Leptæna tenuistriata : Hall, Palæontology of New-York, Vol. i, p. 108.
Leptæna depressa : Hall, Palæontology of New-York, 1852, Vol. ii, p. 257.
Strophomena rhomboidalis : Davidson, Intr. Nat. Hist. Brachiopoda.
" " : Ib., Monograph of the British Carboniferous Brachiopoda, p. 119. 1860.
*Strophomena rugosa** : Hall, Palæontology of New-York, Vol. iii, p. 195. 1859.

The shell is more or less semielliptical or subquadrate, varying greatly in its proportions of length and breadth : hinge-line straight; cardinal extremities sometimes rounded, sometimes acute and slightly produced. The valves are geniculated, and the proportions of the flattened part or disc and the recurved part of the shell are very variable, insomuch that the geniculation is sometimes little more than one of the strong concentric wrinkles.

The surface of the flattened portion is marked by concentric (and sometimes interrupted) wrinkles, which, following the curve of the outline, are bent outwards, and often become obsolete on the cardinal angles. These concentric wrinkles are very variable in number, being from six to fifteen or sixteen upon specimens from the same rock. The entire surface is covered by radiating threadlike striæ.

In young specimens there is usually a round foramen in the apex of the dorsal valve, which becomes closed at a later period. The triangular foramen of the ventral area is partially closed by a deltidium and the apex of the ventral valve.

This species is not of frequent occurrence in the Schoharie grit, but is found everywhere in the Corniferous limestone. The principal varieties are illustrated in figures 16, 17 & 18 of Plate xii, the two latter being essentially casts of the interior. In all the collections made in New-York, we have no specimens of this species from the Hamilton or Chemung groups.

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* I adopted the name *S. rugosa* in the third volume of the Palæontology, recognizing it as the typical species of the genus, and thus named by Rafinesque. The name of Wahlenberg has precedence in time, and will include those lower silurian forms described as *Strophomena* or *Leptæna tenuistriata*.

Genus Strophodonta (Hall).

The Genus Strophodonta was originally proposed for strophomenoid shells, having a crenulated hinge-line, without foramen in the area of the ventral valve. The internal characters were not at that time fully known, and therefore could not be included in the description.

In *S. demissa*, which was regarded as the type of the genus, the area of the ventral valve is free from any indication of foramen; the dental lamellæ are partially or essentially obsolete, and the divaricator muscular impressions are spreading flabelliform without limitation by an elevated ridge. In the dorsal valve, the cardinal process is bifurcate from its origin, and is directed backwards beneath the area of the ventral valve. On the lower side of this ventral area there is a bilobed callosity or process which is more or less prominent and embraced by the divisions of the cardinal process of the opposite valve; thus strengthening the articulation of the valves, or assisting in keeping them in position. The divisions of the cardinal process often extend so far beneath the area as to form conspicuous pits in the substance of the shell within the umbonal cavity.

The valves are so closely articulated by the interlocking of these processes, that the separated ventral valves are usually broken in the middle of the area: this happens also to other species, and it is comparatively rare to find the inner margin of the ventral valve entire. This accident is probably caused by the pressing or crushing of the dorsal valve into the cavity of the ventral valve, while the central portion of the two, remaining firmly united, carries away the middle of the ventral area, which is thinner on each side of the median.

In the *S. reversa* of Iowa, this bilobed process of the ventral area is very conspicuous; and in some specimens of this and of *S. lepida*, the central process remains very prominent, while the margin of the area on either side is indented by the branches of the cardinal process of the opposite valve. In these species we not only have no evidence of triangular foramen, but there is an absolute thickening on the lower side and

a process extending therefrom, which, in its indented front margin, leaves a space for the protrusion of a minute pedicle.

The question of the presence or absence of a foramen, or the smooth or crenulated hinge-line, might not alone or together be of sufficient importance to indicate a distinct genus; but taken collectively with the form of the muscular impressions and other points, we find so wide a difference from the typical species of STROPHOMENA, that it appears to me the separation is required. Were we to unite typical STROPHOMENA with the forms I have designated STROPHODONTA, we could, with equal propriety, unite many of the STREPTORHYNCHUS in the same group.*

The distinction among the genera or subgenera of the strophomenoid shells does not, in all cases, appear to be satisfactorily determined; and we may be often disposed to regard a newly-observed feature as characteristic and reliable for generic determination, when the same may be found in species where the associated characters are incompatible. Among other examples we find one or more forms with crenulated hinge-line, where the area is well defined on both valves, with the triangular foramen closed by a convex deltidium, but otherwise resembling STREPTORHYNCHUS.

It may be doubtful how far the presence or absence of dental lamellæ should influence our considerations in determining the generic relations; and whether the form of the cardinal process, its extension backwards or inclination forwards, should influence the decision.

Among the forms which I have designated STROPHODONTA, we have a group of species, following the typical form in their internal characters, in which we may enumerate *S. demissa*, *S. inequiradiata*, *S. concava*, *S. hemispherica*, *S. nacrea*, and some others.

In another group of nearly flat species, we find the partial or entire absence of foramen and dental lamellæ, with broad spreading muscular

* In the Canadian Journal of July 1861, Mr. BILLINGS, in endeavoring to prove the identity of STROPHODONTA and STROPHOMENA, has given as an illustration of the latter genus the *S. filitexta*, which is a STREPTORHYNCHUS. If the characters of the recognized Genera STROPHOMENA and STREPTORHYNCHUS are so similar as to deceive this acute observer, it may be supposed that differences of equal value between STROPHODONTA and STROPHOMENA may have escaped notice.

impressions, as *S. perplana*, *S. textilis*, *S. alveata*, and in the Lower Helderberg group the *S. beckii*.

There are still some other forms which make a distinct natural group, in being all resupinate, and in having the dental lamellæ continued in an elevated border which nearly surrounds the divaricator muscular impressions. We have but two representatives of this group in the higher formations, the *S. ampla* and *S. viduus*, the former of which is perhaps identical with *S. headleyana* and *S. punctulifera* of the Lower Helderberg group. The *S. leavenworthana*, which is a very marked species, belongs to the same group; and by a little extension of the characters, the *S. striata* of the Niagara group may be included: the two latter have a cardinal process more like STREPTORHYNCHUS. By a farther step, we may include the species I have described as *Strophodonta semifasciata*, which has an area on both valves, and on each one a triangular foramen closed by a convex deltidium. With all these features of STREPTORHYNCHUS, together with a cardinal process similar to other species of that genus, I have found that the hinge-line is crenulated for one-third the length on each side of the centre. The principal ground on which this one could be separated from STREPTORHYNCHUS is the crenulated hinge-line; although the striæ are somewhat dissimilar, and we do not fully know the ventral muscular impressions. Were we to admit that STREPTORHYNCHUS may have a crenulated hinge-line, then going one step further, and taking the form of muscular impression and cardinal process, leaving out of consideration the closed area, we may include in the Genus STREPTORHYNCHUS other species enumerated in this group. This would leave for STROPHODONTA a more natural assemblage of species than are at present united under that genus.

In every one of the characters used to distinguish STROPHOMENA, STROPHODONTA, LEPTÆNA, and STREPTORHYNCHUS, there are gradations or variations on the one side or the other, which ally the species so far that it becomes often no easy task to indicate the limits of the genera; and the additional information obtained from the internal structure of numerous species has not served to clear up the difficulties.

STROPHODONTÆ OF THE UPPER HELDERBERG GROUP.

Strophodonta demissa.

PLATES XI & XII.

For description and references, see the same species under Hamilton group, p. 101.

This species, which has been made the type of the genus, first appears in the Schoharie grit, where it is not of unfrequent occurrence.

The figures 14, 15 and 16 of Plate xi, are illustrations of specimens found in this rock. The specimens usually occur as casts of the interior and impressions of the exterior of the shell. The coarse material of the rock prevents the preservation of the muscular impressions with that degree of distinctness which we find in the same species in the Hamilton group, where the material is finer. At the same time it is probable that the shell has been thinner in the Schoharie grit than in the higher formations, since the striæ are more strongly marked on the casts.

Figure 15, Plate xi, is a cast of the interior of a ventral valve, and figure 14 shows the character of the exterior shell of the same from a cast made in the natural mould.

Figure 16 is a dorsal valve, which is very thick and strong, occurring in a more calcareous portion of the rock.

Figure 17 is a cast of the interior of a ventral valve, showing the muscular impressions.

Commencing in the Schoharie grit, the species occurs in the Corniferous limestone in the form and condition represented on Plate xii, figs 1–5: it is rarely seen of larger dimensions. It attains its maximum development in the Hamilton group, occurring in great numbers, and sometimes attaining a length of one and a half by one and three-fourths inches in breadth. It continues in the Chemung group, where, in the arenaceous beds, it exhibits a character similar to specimens from the Schoharie grit.

Strophodonta alveata.

PLATE XI.

Strophodonta alveata: Hall, Sixteenth Report on the State Cabinet, p. 36. 1863.

This species is known only as casts of the interior and impressions of the exterior. In the young shells, the casts of the ventral valve are slightly convex; while in older specimens they are flat or slightly concave, with the margin more or less recurved. The form is semi-elliptical, and the

hinge-line is sometimes a little longer and sometimes a little less than the width of the shell.

The occlusor muscular imprints are small and deeply marked, and the impressions of the divaricator muscles form together an elongate-ovate scar, with the sides nearly straight, and each division showing two or three lobes. Near the exterior margin of the valve there is a depression reaching from the hinge-line entirely around the front of the shell, indicating a callosity upon the interior of the valve, which is marked by striæ and by vascular impressions in well preserved specimens.

The cast of a dorsal valve of the same form, and associated with the ventral valves, shows the imprint of the submarginal callosity, with vascular markings and a crenulated hinge-line: the cardinal process is bifurcate, and directed outwards as in other species of the genus.

The length of the shell is from one-half to three-fourths of an inch, with a somewhat greater breadth.

Figure 3, Plate XI, is a young individual in which the ventral valve has a slight convexity, and the muscular impression is but faintly defined in the lower part; while in fig. 2, an older specimen, it is a little concave, with a strongly defined muscular impression.

The characters of the species, as represented in the figures of the ventral valve, are constant in as many as nine or ten individuals under examination, and they show no near approach to any other species in the collection. Fig. 1 is the interior of a dorsal valve, which has been referred to this species from its association and similarity of form, while the vascular impressions also correspond in the two valves.

Geological formation and localities. In the Schoharie grit at Clarksville, and at Knox, Albany county, N. Y.

Strophodonta callosa.

PLATE XI & XX.

Strophodonta callosa: HALL, Sixteenth Report on the State Cabinet, p. 36. 1863.

CASTS of the ventral valve are semi-elliptical, longer than wide or with nearly equal length and breadth, very convex or gibbous; across the

middle of the valve, the width of the shell is greater than at the hinge-line. The area is comparatively wide and much elevated in the centre; the hinge-line strongly crenulated. Muscular impressions comparatively large and deeply marked, separated by a rather wide groove which reaches more than halfway to the base of the shell.

The entire margin of the valve (in the casts) is elevated in a narrow band, within which it is abruptly depressed; and the space between the callosity and the muscular impression is marked by punctate vascular impressions.

In five well-marked individuals, like fig. 9 *a*, *b*, of Plate XX, the casts are rarely more than half an inch in length, and are readily recognized by their great convexity, narrow elevated border, and comparatively short hinge-line.

A dorsal valve found associated with the ventral valves is represented on Plate XI, fig. 4, which is enlarged from a mould in the gritstone : it has the margin abruptly recurved, with a callosity extending along the border. The cardinal process is slender and bifurcate.

In comparing a larger number of specimens, it appears that the well-marked *S. callosa* may pass by several gradations into another form which is even more numerous in individuals than the form described. In the absence of the shells, it may be impossible to decide satisfactorily; but it appears not improbable that the *S. callosa* (as originally described) is an extreme variety of a more regularly convex shell which is proportionally shorter, and sometimes possesses the callosity near the margin in a moderate degree, but is often free from such marking.

The prevailing form is the following :

Strophodonta callosa, *var.*

PLATES XI & XV.

Shell semielliptical. Ventral valve regularly convex, the greatest convexity about the middle of the shell : hinge-line straight, strongly crenulated, varying from a little less to a little more than the width of the shell; apex elevated above the hinge-line; area of moderate width.

In the casts there is a narrow longitudinal mesial depression, often reaching more than halfway to the base; the apex is distinctly bilobed; the marks of the occlusor muscles make two well-defined prominences;

and the divaricator muscular impressions are broad, spreading, and somewhat truncate on their lower margins. The lateral and basal margins are usually a little more strongly marked by the impressions of the surface striæ; and sometimes there is a partial or entire elevation of the part, or a callosity more or less defined.

Figures 6 & 7, Plate XI, are of the natural size of the shells.

Figures 9 & 10 of Plate XI are illustrations of an extreme form of the cast of this shell, where the median depression is much wider than usual, and the lateral margins show a partial callosity,

A cast taken from an impression of the dorsal valve, which occurs in the same association with the ventral valves, gives the characters shown in figure 8 of Plate XI, differing but slightly from figure 4 : this difference may be owing to the imperfect preservation of the parts in a coarse material.

Among the collections are two or three specimens, which, preserving the shell more or less completely, have the size and form of the casts. In one of these, where the shell is apparently entire, the surface of the middle and lower part of the shell is marked by distant elevated striæ with wide interspaces, which do not show radiating striæ, but are marked by concentric striæ. On the umbo, the surface is marked by wide radiating bands without distinct striæ.

In another partially exfoliated specimen, the surface near the margin of the shell shows minute striæ between the coarser ones; and the same characters are partially shown in one or two other specimens.

In the collections before me there are about thirty specimens with the characters described, and all these are of nearly the same size; nor can I trace any connexion between these and any of the larger forms. Notwithstanding, therefore, that I am opposed to creating new species where it can be avoided, and knowing that the species of this genus have been unnecessarily multiplied, I must regard this as a distinct and well-marked form. In its dimensions, it corresponds with the next described species, but differs in its surface markings and form of muscular impressions. It is nearly of the same size as *S. nacrea*, but differs in the greater convexity of the ventral umbo, and in the form of the muscular impressions as well as in the surface-markings.

The illustrations on Plate XV show the form of muscular impression, surface striæ, etc.

Geological formation and locality. In the Schoharie grit at Clarksville and Knox in Albany county. The species is not at present known in the Corniferous limestone.

Strophodonta parva.

PLATES XI & XV.

Strophodonta parva : Hall, Sixteenth Report on the State Cabinet, p. 37. 1863.

Shell small, subhemispheric, a little wider than long : hinge-line equalling or shorter than the width of the shell; cardinal extremities rounded. Ventral valve gibbous : umbo elevated above the area-line; apex incurved; area linear.

Surface marked by few rounded or subangular costæ, which are simple on the upper part of the valve, but each one dividing into two or three above, or in the middle of the shell, and are often farther divided on the margin; those of the ventral valve often increase by subdivision, while those of the dorsal valve increase by intercalation. The larger striæ are covered by fine undulating or interrupted longitudinal striæ, and are sometimes marked by a sharp elevation along the middle.

The casts of the interior of the ventral valve rarely show the muscular impression with much distinctness; the surface being marked as if by fascicles of fine striæ, with sometimes a sharp elevated one between. The apex is bilobed; the occlusor impressions small and well marked, and the divaricator muscular imprints are broad and spreading.

Impressions of the exterior of the dorsal valve are common, and are readily distinguished by the strong subangular costæ on the upper part, while they become grooved and increase by intercalation on the lower part of the mould.

In exfoliated specimens, the surface has the aspect of those with fascicles of striæ and sharp elevated striæ between.

The form and proportions of the species seem to be pretty constant, rarely exceeding and usually less than half an inch in width. The ordinary condition of the specimens is that of casts, or of impressions of the exterior shell; while in the more calcareous part of the rock, specimens preserving the shell have been obtained.

The form and proportions are not materially unlike those of *S. callosa*; but the striæ are much stronger, the muscular impression of different form, and the surface of the casts much more distinctly marked by the impressions of striæ.

Figure 5 of Plate XI is from the impression of a dorsal valve; and figure 11 of the same plate is a cast of the ventral valve enlarged two diameters, showing the muscular impression and marks of the striæ. Farther illustrations are given on Plate XV.

Geological formation and locality. In the Schoharie grit, at several localities in Albany and Schoharie counties.

Strophodonta crebristriata.

PLATE XI.

? Strophomena crebristriata : CONRAD, Jour. Acad. Nat. Sciences, Vol. viii, pa. 254, pl. 14, f. 3.

SHELL semielliptical; length and greatest width nearly as two to three. Ventral valve convex or moderately gibbous, more elevated in the centre : hinge-line straight, with the extremities usually a little salient; area linear and finely crenulated; the beak slightly prominent, and a little incurved. Dorsal valve concave, following the form of the ventral valve.

SURFACE marked by fine crowded striæ which regularly bifurcate from their origin, or sometimes in fascicles of threes which again subdivide.

Mr. CONRAD's description of *S. crebristriata* is as follows :

"Semi-orbicular, with fine crowded bifurcating radii; inferior valve ventricose, "slightly depressed or flattened in the middle; sides depressed or concave to- "wards the hinge margin, the extremities of which are slightly salient and not "very acute; summit of the umbo elevated above the hinge-line." This species is cited as occurring both in the Schoharie grit and in the limestone above.

The specimens described are all from the Schoharie grit. The smaller ones are about half an inch in length, and the larger ones of the same character are an inch in length by one inch and a half in width. In the younger specimens, and those of medium size, the cardinal extremities are a little salient, and this character prevails in nearly all the specimens.

I had referred the smaller specimens, with some hesitation, to the *Strophomena crebristriata* of CONRAD; but the gradations to those of larger size are quite imperceptible, and all must be included under one designation.

Figure 12 represents a young individual, and figure 13 is twice enlarged.

The figures 18 & 19 are ventral and profile views of a large individual, and the fasciculate striæ upon the inner surface of the shell are shown in figure 20.

The specimen figure 21 is a larger individual, with similar crowded striæ and rounded cardinal angles.

In the well-marked specimens of this form, I have not been able to learn the character of the muscular impressions; and in one small specimen only I have seen a short bifurcating cardinal process.

Among some obscure specimens from the same localities are some casts of dorsal valves which are much elevated, or obtusely subcarinate along the centre, with duplicating striæ. One of these shows a cardinal process and muscular impression, as illustrated in figure 23 of Plate xi. This may be identical with the preceding form.

Geological formation and locality. In the Schoharie grit at Clarksville and Knox in Albany county, and at Schoharie.

Strophodonta inequiradiata.

PLATES XI, XII & XIII.

Strophodonta inequiradiata : Hall, Tenth Report on the State Cabinet, p. 113. 1857.

Shell semielliptical or semicircular, more or less gibbous, approaching a hemispheric form : cardinal extremities sometimes salient, but often rounded, and the cardinal line less than the width of the shell below. The ventral valve varies from moderately convex to gibbous, often forming a somewhat regular arch from beak to front, usually with the greatest convexity above the middle, depressed and often concave between the umbo and the cardinal extremities, which (in perfect shells) are somewhat salient : beak a little elevated above the hinge-line, and incurved; area very narrow, linear and finely crenulate. The dorsal valve is concave, often in a less degree than the convexity of the ventral valve; the disc sometimes very slightly concave, and abruptly deflected or almost geniculate towards the front.

The surface presents much variety of character and aspect, both in the original shell and in its partial or entire exfoliation. The striæ on the ventral valve are often coarse and uneven, somewhat fasciculate, and

often rising in ridges which in the exfoliated shell do not show the divisions. Some specimens have the striæ sharp and slender, and nearly equal, with wider plain intermediate spaces. On the dorsal valve the striæ are pretty uniform; the stronger ones being distant, sharp and elevated, with wide intermediate spaces marked by extremely fine regular striæ, from the midst of which, as the shell increases, the elevated striæ arise, dividing the space in which the smaller striæ are constantly increasing by intercalation.

The modifications in the expression of the surface striæ, in the specimens, are represented on Plate XI, figures 25, 29, 30 & 31, and on Plate XIII, figures 6 – 8. In the latter figures the striæ are uneven, and rise in ridges with irregular interspaces.

In figure 29, Plate XI, which is a cast of the ventral valve, there are regular interspaces between the fine elevated striæ, a character more usually observed in the dorsal valve.

The muscular impressions of the ventral valve show narrow elongate scars for the occlusor muscles, and the divaricator muscular impressions are spreading, flabelliform, and deeply striated. In many of the casts, the lower part of the specimen is marked by strong vascular impressions, which are shown in figures 26 & 27 of Plate XI. The muscular impressions of the dorsal valve are narrow and elongate, and the cardinal process is usually comparatively slender. The interior surface of the valves is granulose or pustulose.

This species approaches the *S. patersoni;* and in some specimens, it is not easy to decide the specific differences. In the latter species, the muscular impressions of the ventral valve are smaller and shorter, while the wide interspaces between the stronger striæ on the ventral valve are characters not observed in any of the numerous authentic specimens of *S. inequiradiata :* at the same time, there are many obscure specimens in the Schoharie grit and Corniferous limestone, which it is difficult to refer satisfactorily to either of the species described.

The *S. inequiradiata* is entirely distinct from the *S. inequistriata* of CONRAD, with which it has been sometimes united*, as will be shown under the description of that species in the Hamilton group.

Geological formation and locality. In the Schoharie grit in Albany and Schoharie counties; and in the Corniferous limestone of the Helderberg mountains, Schoharie, Cherry-valley, and other places.

* It is perhaps unfortunate that the name has the same signification.

Strophodonta patersoni.

PLATES XII & XIII.

Strophomena (Strophodonta) patersoni : Hall, Tenth Report on the State Cabinet, p. 114. 1857.

Shell semioval. Ventral valve convex, becoming gibbous in the middle, somewhat deeply deflected at the sides and front; sometimes marked by a few radiating undulations or folds, which affect both ventral and dorsal valves towards the front : hinge-line straight; extremities often salient.

Surface marked by distant elevated radiating striæ, and the intermediate spaces by undulating fine striæ, and crossed by short abruptly arching wrinkles which are interrupted by the strong radiating striæ. The finer radiating striæ on the ventral valve are from three to ten or twelve between the stronger ones; while on the dorsal valve the spaces are wider, and there are from ten to twenty finer striæ between the stronger ones. The finer striæ are crossed by equally fine concentric striæ, giving the entire surface a delicately cancellated appearance.

The short interrupted arching wrinkles vary extremely in strength; usually becoming obsolete towards the front of the shell, and in some specimens are scarcely or not at all perceptible.

In young shells the cardinal extremities are very salient, the ventral valve moderately convex, usually becoming more so as the shell increases in size, but sometimes continuing of moderate convexity till more than half grown; but in such specimens, the margin is sometimes abruptly inflected. Older specimens become very gibbous, and sometimes longitudinally wrinkled.

In one specimen partially preserving the shell (fig. 2, Plate xiii), the muscular impression of the ventral valve is of the same form as in *S. inequiradiata*, but smaller. In a cast preserving the striæ upon the margin, as in characteristic specimens of the species, the muscular impressions are likewise small, but exhibit the same form as the one figured. In a

single dorsal valve, recognized as of this species, the cardinal process is slender, the parts narrowly diverging, and continued in a narrow rounded elevation to the middle of the valve. No defined muscular impressions are visible in this specimen.

The figures 9, 10 & 11, Plate XII, and figures 1 – 5, Plate XIII, illustrate some of the usual forms and the preceding characters of this species.

Notwithstanding that these characters can be traced through the various stages of growth offering differences from the ordinary forms of *S. inequiradiata*, there may still remain some doubt whether a large collection may not show intermediate forms which will unite the two.

The *Leptæna stephani* of BARRANDE has a similar wrinkled surface in some of the individuals, though the intermediate finer striæ are not shown in the figures. In these two shells, the muscular impressions are quite distinctive; and the figure 7 *b*, Plate X, BARRANDE, approaches in character to some varieties of *S. inequiradiata*. Some varieties of the species under consideration may be compared with *S. corrugata*, PORTLOCK sp. (not of CONRAD).

The species differs in form of shell, character of striæ, and muscular impressions, from the *S. inequiradiata*.

Geological formation and locality. Rarely in Schoharie grit, but not uncommon in the Corniferous limestone, in the Helderberg mountains, Schoharie; in Ontario county; and at Stafford in Genesee county and Williamsville in Erie county. It has likewise been recognised among the collections made at the Bake-oven on the Mississippi river, in Illinois.

Strophodonta hemispherica.

PLATE XIV.

Strophomena (Strophodonta) hemispherica : HALL in Tenth Report on the State Cabinet, p. 113. 1857.

SHELL subhemispheric, semielliptical in outline : hinge-line equalling or greater than the width of the shell; cardinal extremities sometimes salient and auriculate; length and breadth about as four to five : in the larger specimens the length is about two inches, with a breadth of two and a half inches. Ventral valve gibbous, the elevation of the curvature being often equal to half the length of the shell, sometimes very abruptly declining to the front : umbo moderately, or sometimes more extremely elevated; apex incurved; area narrow; margin cre-

nulated. Dorsal valve moderately concave on the upper and middle part of the shell, and abruptly deflected or geniculate towards the front.

SURFACE marked by fine radiating striæ, which are somewhat unequal on the upper and middle portions of the ventral valve, but are fine and regular towards the margin. In some specimens of the dorsal valve, the striæ show a tendency to the alternation of three or four finer ones with a distinctly stronger one between; but in the greater number of specimens, the striæ are fine, close, and mostly equal in strength. The radiating striæ, when perfect, are crenulated by extremely fine concentric striæ : sometimes a few obscure concentric wrinkles mark the umbonal region, and some specimens show undefined longitudinal folds.

In the ventral valve, the occlusor muscular impressions are strongly marked in elongate semielliptical imprints; while the divaricator muscular impressions are elongate flabelliform, often reaching half the length of the valve. The specimen figured on Plate XIV is shorter than usual.

In the dorsal valve the muscular impressions are strongly marked, and divided by a low median ridge, which is continued above as a rather strong bifurcate cardinal process : hinge-line rather coarsely crenulated.

This shell differs from *S. inequiradiata*, in attaining a larger size, and in being more gibbous on the ventral valve. The striæ are finer and more equal, and the muscular impressions larger; while the vascular impressions, so common in casts of that shell, have not been observed in this one.

Its fine and nearly equal striæ, as well as its greater gibbosity, distinguish it from *S. patersoni*. It approaches very nearly the *S. concava* of the Hamilton group; and the two have so many characters in common, that I have hesitated to continue them as distinct species. A larger collection of the limestone specimens are needed, before a satisfactory comparison can be made.

The figure 2 *a* on Plate XIV illustrates the exterior of a dorsal valve, where the cardinal extremities are auriculate. The profile view, figure 2 *b*, is a little less gibbous than usual.

The interior of the dorsal valve is shown in figure 2 *c*; and the cardinal view, figure 2 *d*, shows the muscular impressions of the ventral valve.

Geological formation and locality. This species occurs in the Schoharie grit in Albany and Schoharie counties, and not rarely in the Cornifereus limestone in nearly all localities of this formation throughout the State; and I have a specimen

from Port Colborne, Canada West, which is apparently identical with it. The finest and best characterized specimens which I have seen are from the Falls of the Ohio; and it occurs in almost equal perfection at Columbus and Sandusky, Ohio.

Strophodonta perplana.

PLATES XI & XII.

Strophomena perplana : CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. viii, p. 257. 1842.
Strophomena crenistria : HALL, Geol. Rep. 4th District, p. 171, f. 4.
For description and references, see the same species under the Hamilton group.

A comparison of large numbers of specimens of this species, from the base of the Lower Helderberg to the Hamilton and Chemung groups inclusive, embracing those described under several different names, has satisfied me that they must all be referred to a single species. There is, however, a similar species in the Tully limestone, which in the character of its surface striæ, the pustulose or punctate interior surface of the valves, and the form of the muscular impressions, is very distinct from this one.

This species begins its existence, so far as at present known, at the commencement of the Schoharie grit, where it is not infrequent. It occurs as casts of the interior; those of the dorsal valve being the more common. It appears in the Corniferous limestone, where it attains large dimensions. It was a ventral valve of this species imbedded in limestone, having the surface rather better preserved than usual, to which I originally gave the name of *S. crenistria*.

The figure 22 of Plate XI is a cast of the ventral valve from the Schoharie grit.

Figures 13 & 14 of Plate XII are a small and large specimen of the shell, with nearly even striæ, as it occurs in the Corniferous limestone.

Figure 15 is a cast of the same species, where the muscular impression is very large.

Geological formation and locality. In the Schoharie grit, at Clarksville and Knox, Albany county and at Schoharie, in the limestone at Williamsville and Clarence-hollow, Erie county; at Louisville, Kentucky; and in Indiana.

Strophodonta inequistriata.

PLATE XII.

Strophomena inequistriata : Conrad, Jour. Acad. Nat. Sci. Phila., Vol. viii, pa. 254, pl. 14, f. 2.

This species was originally described by Mr. Conrad from the Moscow shales of the Hamilton group, where it occurs in considerable numbers.

Among the collections from the Corniferous limestone are a few specimens quite undistinguishable from those of the Hamilton group, and which I have referred to this species.

The figures 6 & 7 of Plate xii are ventral and dorsal views of a well-marked individual, which is of the ordinary size of the species.

Figure 8 is a profile view of a very gibbous specimen, which has a more strongly marked surface, resembling *S. patersoni;* but the specimen is much more gibbous than any authentic individuals of that species.

Farther illustrations are given on Plate xviii.

Geological formation and locality. In the Corniferous limestone, near Caledonia, Livingston county.

Strophodonta ampla.

PLATE XIV.

Strophomena (Strophodonta) ampla : Hall in Tenth Report on the State Cabinet, p. 111. 1857.
Strophomena ampla : Billings in Canadian Journal.
Strophomena ampla : Geological Report of Canada, p. 368. 1863.
Compare *Strophodonta headleyana, S. punctulifera,* and *S. cavumbona* : Pal. New York, Vol. iii, pp. 186–188.

Shell large, broad, semioval or subsemicircular; length from two-thirds to three-fourths as great as the width; hinge-line equalling or longer than the width of the shell below, with extremities often a little salient. Ventral valve concave, with a slight convexity about the umbo, and very rarely a mesial elevation extending from the beak nearly to the front of the shell. Dorsal valve convex in the middle,

sloping to the margin, and flat or concave upon the umbo : hinge extremities often slightly deflected to the dorsal side.

Area of the ventral valve from one to two lines in width, and variously inclined to the plane of the lateral margins of the shell, transversely striated and the inner margin crenulated for about half the distance from the centre to the cardinal extremity; the remaining portion marked by a narrow groove (the latter feature not always distinct). The foramen is closed, a smooth triangular space marking its place, with a narrow callosity along its centre. Area of the dorsal valve narrow and linear throughout.

Surface marked by angular subequal interrupted or rugose striæ, which are often made to appear more equal and uniform by the partial exfoliation of the shell. The striæ are bifurcated two or three times before reaching the margin, and they are sometimes increased by intercalation. As usually preserved, they rise at intervals into sharp ridges or elongate nodes; and in well-preserved specimens, these are produced into short spines.*

When the shell is exfoliated, the surface between the striæ is marked by minute pores or tubular openings, which communicate with pustulose elevations on the interior surface of the shell. In the entire cast, these pores mark the surface with considerable regularity, varying in size, and uniformly larger below the middle where the valve is more abruptly deflected.

The muscular impressions of the ventral valve are very large and broad, and the margins distinctly limited by a curving elevated border. It is divided in the middle by a more or less developed septum, which terminates in a prominent callosity beneath the place of the foramen : this callosity gives a bilobate character to the cast of the rostral cavity. The place of the occlusor muscles is strongly marked, and that of the divaricator muscles distinctly lobed. The muscular imprints are about two-thirds as long as wide, and the width is often nearly equal to half the

* This feature is rarely preserved in parts of the surface in our specimens; but Mr. Billings has figured a specimen with the entire surface covered with short spines (*Canadian Journal*, loc. cit.).

width of the shell. The muscular impressions of the dorsal valve are narrow and elongate, and are separated by a rounded median ridge which divides above and continues in two diverging processes, the full extent of which is not shown in any of our specimens.

This species of the Upper Helderberg group offers no important differences from the *S. headleyana* of the Lower Helderberg rocks, although that species has not been observed in the intermediate formation of the Oriskany sandstone. It may be doubtful, moreover, whether a more extensive series of specimens would not show that this form, the *S. headleyana*, *S. cavumbona*, and *S. punctulifera* are all of one species presenting variations of size, degree of convexity, width of area, and differences of surface markings, due to the influence of the sediment and other surrounding conditions which affect the development of animal life.

In the Lower Helderberg specimens of *S. headleyana*, so far as observed, the concavity of the ventral valve is usually uniform; and only in two specimens from the Corniferous limestone have I observed an elevation along the middle, which, in one specimen, is raised into an angular ridge. The muscular impressions of the specimens in the Corniferous limestone are always proportionally larger than those of the Lower Helderberg formation.

The figures 1 *a*–*i* on Plate XIV illustrate the gradations in size, from a specimen three-fourths of an inch to one of two inches and a quarter in length.

Figure 1 *b* is an impression of the dorsal valve, showing the punctate surface and the cavities of the cardinal process.

In figure 1 *g* the triangular space indicating the usual position of the foramen is differently tinted, and the narrow callosity is shown along the middle. The striated or crenulated portion of the area is likewise limited, as shown in the figure, though less distinctly in the specimen. The inner edge of the area is indented on each side of the middle, corresponding to the branches of the cardinal process, as shown in figure 1 *h*, while the callosity beneath the centre protects that portion which is more prominent.

The figure 1 *i* is a cast from the Schoharie grit.

Geological formation and locality. In the Schoharie grit, in Albany and Schoharie counties; and in the Corniferous limestone in the Helderberg mountains and at Schoharie; at Cherry-valley; Onondaga-hollow; Clarence-hollow: Williamsville; and in all localities of the limestone.

STROPHODONTÆ OF THE HAMILTON GROUP.

As already indicated, several species of STROPHODONTA pass from the Schoharie grit and Corniferous limestone to the Hamilton group. The principal among them are the *S. demissa*, *S. perplana*, *S. inequistriata* and *S. nacrea :* of these, the two first pass into the Chemung group. It may, perhaps, be questioned also whether the *S. hemispherica* of the Corniferous limestone may not assume the form to which I have given the name *S. concava* in the Hamilton Group.

Those species which begin their existence below the horizon of the Hamilton group, and pass into the Chemung group, have their greatest development in the Hamilton group, in number of individuals, in size, and in development of parts, with perhaps the exception of the extravagant forms of *S. perplana* in the Chemung group.

Strophodonta concava.

PLATE XVI.

Strophomena (*Strophodonta*) *concava* : HALL in Tenth Report on the State Cabinet, p. 140. 1857.
Also *S. concava* : Idem, p. 115. 1857.

SHELL large, from two to three and a half inches wide on the hinge-line, concavo-convex or subhemispheric, broadly semielliptical or subcircular, sometimes subtriangular from becoming narrowed in front. The proportions vary from nearly equal length and breadth to a width one-fourth to one-third greater. The hinge extremities are sometimes salient, but often rounded.

VENTRAL valve varying from moderately to extremely convex, and becoming gibbous in the middle, rounded upon the umbo and little elevated above the hinge-line, with beak small and scarcely incurved : in some specimens, the centre of the valve is elevated in a median ridge. Dorsal valve usually almost flat or slightly concave in the upper and central portions, becoming suddenly deflected towards the margin; in some specimens, regularly concave.

Area of the ventral valve nearly on a plane with the axis of the shell, about a line in width, gently narrowing towards the extremities, vertically striated, with the margin crenulated for more than half the distance from the centre to the extremities. Area of the dorsal valve almost rectangular to that of the ventral valve, very narrow and nearly linear throughout, sometimes narrower in the middle, striate and crenulate as in the opposite valve; with a small, smooth triangular space beneath the apex.

The surface of the ventral valve is marked by sharply elevated, strongly crenulated striæ, between which are sometimes one or two less elevated striæ similarly crenulated, and still finer striæ between the latter. In other specimens there are wider spaces of finer equal striæ between the stronger ones; and, in still other examples, the striæ are nearly all strong and sharply elevated, with few finer ones, which soon rise to the strength of the others. Close undulating concentric striæ cover the whole surface. The dorsal valve is marked by distant sharp elevated striæ, between which there are from three to six and rarely ten finer striæ, which are very finely crenulated by concentric striæ.

In some specimens the ventral valve is marked by an irregular fold or ridge down the middle, and there are sometimes a few incipient plications on one or both sides towards the margin of the shell. These plications likewise affect the dorsal valve.

The interior of the valves is finely pustulose. The divaricator muscular impressions of the ventral valve are large and spreading, about as wide as long, extending nearly half the length of the valve, and deeply striate; while the occlusor impressions are elongate-ovate or cordiform, and strongly marked. The muscular impressions of the dorsal valve are strong and divided above by a rounded ridge which supports the strong bifurcate cardinal process, each division of which is bilobed, and the surfaces roughened for the muscular attachment.

Some of the more characteristic forms of this species are illustrated on Plate xvi. In a large number of specimens, the convexity of the ventral valve is less than in the figure given.

This species is closely allied to the *S. hemispherica*, differing in the surface marking, and to some degree, in the muscular impressions; and it is impossible to determine how far these modifications may extend, without a large series of specimens in better preservation than usually found. In the Hamilton group, the species is subject to considerable variety of form and convexity, but is always readily recognized among the other species of the group. In the collections there is a single example of a dorsal valve, which is moderately concave for a little more than half its length, with some obscure concentric wrinkles; beyond this, it is deflected almost at right angles to the plane of the upper part of the shell. The muscular impressions are shorter and wider than usual, and the cardinal process is shorter and stronger. In comparison with the prevailing forms, this might have been regarded as a distinct species.

Geological formation and locality. This species occurs rarely in the Corniferous limestone in New-York, and is very common in the soft shales of the Hamilton group in all the localities from Cayuga lake westward to Lake Erie. It is apparently limited to the upper beds of the group, or to the Moscow shale, and is comparatively rare below that horizon. At the present time, it is unknown to me in any position higher than the Hamilton group.

Strophodonta perplana.

PLATES XI, XII, XVII & XIX.

Strophomena perplana : Conrad, Jour. Acad. Nat. Sciences, Vol. viii, pa. 257, pl. 14, f. 11. 1842.
Strophomena pluristriata : Conrad, ut sup. p. 259.
Strophomena detthyris : ut sup. pa. 258, pl. 14, f. 19.
Strophomena crenistria : Hall, Report Fourth Geological Dist. New-York, p. 171, f. 4. 1843.
Strophomena (Strophodonta) fragilis : Hall, Tenth Report on State Cabinet, p. 143. 1857.
Strophodonta fragilis : Hall, Report Geological Survey of Iowa. pa. 496, pl. 3, f. 6*a*, 6*c*. 1858.

Shell semielliptical; the length varying from two-thirds to three-fourths the width, which is from half an inch to two inches; slightly concavo-convex, and often nearly flat : hinge-line equalling or often a little greater than the width of the shell below; the extremities usually somewhat salient, except in extremely old shells. Margins of the shell often a little contracted just below the hinge-extremities, making the width less than below; but the sides are frequently nearly straight for half their length, and the front broadly rounded with the margin attenuate.

VENTRAL valve very little convex, the greatest convexity above the middle of its length, with frequently a few obscure concentric wrinkles near the apex, and sometimes upon the body of the shell: apex scarcely rising above the hinge-line, and slightly incurved. Dorsal valve gently concave, and often nearly flat.

AREA of the ventral valve usually less than a line in width, inclined at an angle of 40° to 50° to the plane of the margins and curved in the upper part, vertically striated in its whole extent and crenulate on the inner margin; sometimes a flat triangular space in the place of a foramen, with a narrow callosity in the middle, but this feature is not always observable. Area of the dorsal valve about half as wide as that of the ventral, gently curved outwards, leaving an angle between the two of more than 90°: the centre is marked by a narrow callosity or an impressed space.

SURFACE covered by fine subequal striæ, those of the ventral valves being the finer, extremely sharp and often gently undulating, increasing both by bifurcation and intercalation, and crossed by fine, even concentric striæ. In some specimens the longitudinal striæ rise at frequent and regular intervals into minute granules, evidently the bases of minute spines, which have covered the surface of the ventral valve. The dorsal valve is marked by fine even rounded striæ which are cancellated by close concentric striæ, and the same obscure concentric undulations as are observed on the surface of the ventral valve. Very rarely there is some interruption to the regularity of the striæ, apparently owing to an injury which has often caused the concentric striæ to curve towards that point, and the radiating striæ to converge, making a kind of seam or cicatrix.

In specimens of the same species from Illinois and Iowa, the striæ on the ventral valve are less sharp, and arranged in fascicles of four to six finer ones between the stronger and more elevated striæ. In the specimens from the Chemung group, the striæ are often very irregular, rising at intervals into elongate pustulose elevations, and again subsiding to delicate lines.

The interior of the ventral valve is marked by large flabelliform divaricator muscular impressions, extending more than half the length of the shell; narrow above, with sides nearly straight, curving below and deeply divided in front, each division showing four or five lobes. The occlusor impressions are two semioval elevated spots a little below the apex, the centre becoming a thickened ridge or process lying beneath the place of the foramen, with a cavity on each side for the insertion of the bifurcate dorsal cardinal process. The muscular impression is excavated in the substance of the shell, the margin in the upper part being elevated and marked by a row of pustules. In young shells the muscular impressions are often indistinctly limited, but in the older shells are very well defined. The muscular impressions of the dorsal valve are distinctly but not strongly marked : these are separated above by a median ridge which divides in the bifurcating cardinal process, and this is supported on each side by an oblique pustulose ridge which gradually merges into the surface of the shell.

In general, the shell is readily recognized by its nearly flat form and fine nearly equal striæ. In the muscular impressions of the interior, it resembles *S. beckii* of the Lower Helderberg group, but is never so strongly wrinkled. The smoother specimens of that species in limestone are not easily distinguished from the ordinary forms of this one as they occur in the Corniferous limestone.

The original of *S. perplana* of CONRAD was from the Onondaga limestone of the Upper Helderberg group, a specimen about five-eighths of an inch in width.

The *S. pluristriata* of the same author was described from an impression of the ventral valve in arenaceous shale; and similar specimens from the same vicinity as the original show that it does not differ from the *S. perplana*, while casts of that species occur in the same association. The *S. fragilis*, HALL, was described from specimens in the calcareous shale of the Hamilton group in Western New-York, and from the same horizon at Rock island in Illinois.

The *Strophomena delthyris* of CONRAD, from the Chemung group, is doubtless a large individual of *S. perplana*, since I find that similar large casts of this species occur in the same formation.

The figures of Plates XI & XII have already been referred to, pages 81 & 87.

Figures 1*a*–1*d* Plate xvii are of the ordinary forms of the species from the Hamilton group of New-York.

Figure 1*e* shows an enlargement of the area.

Figure 1*f* represents the surface characters of the Illinois and Iowa specimens.

Figures 1*g* and 1*h* are interiors of the ventral valve.

Figure 1*l* is a cast of the ventral valve of a large specimen.

The figures 1 *k*, *u* are of the interior of the dorsal valve enlarged.

Figures 1 *n*–*o* are enlargements of the striæ of New-York and western specimens.

On Plate XIX, figures 15–19, are illustrations of the species as it has been observed in the Chemung group.

Geological formations and localities. . This species is found in the Schoharie grit of Albany and Schohario counties, in the condition of casts of the interior with impressions of the exterior surface. It is found in the Corniferous limestone, usually smaller than the medium size of specimens in the Hamilton group, but rarely in larger forms : occurring in the Heldorberg mountains; at Schoharie; at Cherry-valley, and at Williamsville, N.Y.; and near Columbus, Ohio; and at the Falls of the Ohio river.

In the Hamilton group, it is found at numerous localities throughout the extent of the outcrop. In the eastern part of the State, it usually occurs in the condition of casts of the interior with impressions of the exterior. In the calcareous shales on Cayuga and Seneca lakes, at Moscow, York, Pavilion, Darien, and at Eighteen-mile creek, the shell is preserved in great perfection. We find the species in the same horizon at Rock island, Illinois; and near New-Buffalo, Iowa.

In the Chemung group, it is found at Chemung-narrows; along the line of the Blossburg railroad, and at other places.

Strophodonta demissa.

PLATE XVII.

Strophomena demissa : CONRAD, Journal Acad. Nat. Sciences, Philadelphia, Vol. viii, pa. 258, pl. 14, f. 14. 1842.

Strophomena (Strophodonta) demissa : HALL in Tenth Report on State Cabinet, p. 137. 1847.

Strophodonta demissa : HALL, Report Geological Survey of Iowa, pa. 495, pl. 3, f. 5. 1859.

Strophomena demissa : BILLINGS, Canadian Journal, 1861.

" " " Geology of Canada, p. 367. 1863.

SHELL semielleptical, usually wider than high, length and breadth often nearly equal : hinge-line equalling or greater or less than the width of the shell below, abruptly contracted beneath the extremities, which are often auriculate; in some specimens the sides are nearly straight, and parallel for more than half the length of the shell.

Ventral valve regularly convex, often gibbous; greatest elevation nearly central, and sometimes subangulated along the middle : umbo small and prominent, with the apex slightly incurved and extending beyond the plane of the area; surface a little concave towards the cardinal angles, which are slightly deflected. Dorsal valve moderately concave, rarely following the convexity of the opposite valve; sometimes an undefined median depression extends from beneath the apex to the front of the shell.

Area of ventral valve variable, usually of moderate width, from $\frac{8}{100}$ to $\frac{12}{100}$ of an inch wide in the centre, having a low triangular outline, concave in the middle and for a considerable distance on each side of the beak, strongly striated transversely and more faintly longitudinally, sometimes marked along the middle by a subangular elevation; inner margin crenulated for nearly its entire length. There is no foramen, but sometimes a smooth triangular space beneath the beak. Dorsal area narrow and usually linear, sometimes wider and sometimes narrower in the middle, and the margin for a short space free from crenulations. The planes of the two areas are inclined so as sometimes to give less than a right angle between them, but generally a greater angle, and along the middle the two are often nearly in the same plane.

Surface marked by numerous crowded striæ, about nine or ten of which are much stronger and more elevated on the umbo of the ventral valve, with finer ones coming in between and on either side : striæ frequently increasing by intercalation and bifurcation, until they become very numerous and much finer at the margin. On the dorsal valve, the striæ are similar to those of the ventral valve. In well-preserved specimens, fine concentric striæ cover the entire surface, but the greater number of specimens do not preserve these markings. The coarser striæ are sometimes seen separated on the middle of the shell, each one presenting the appearance of a fascicle of striæ, which, spreading, cover the lower part of the shell with extremely fine crowded striæ.

The interior of the ventral valve, and casts of the same, show a large flabelliform divaricator muscular impression, which is somewhat widely separated in front, and each division distinctly lobed. The occlusor muscular impressions occupy a semielliptical space on each side of a narrow central depression, the marking on either side being double in well-preserved specimens. The upper extremities of this impression are close under the arch of the umbo, and separated by a smooth space from the divaricator impressions.

Beyond the muscular impressions, the interior surface is minutely pustulose, the points being more prominent just without their limits; beyond which, the course of the vascular impressions can be distinctly traced.

In the dorsal valve, the anterior and posterior occlusor muscular impressions are very conspicuous and deeply marked, and often limited by an elevated ridge, a narrow longitudinal ridge dividing the two pairs. On each side, and below the muscular impressions, the surface is marked by small pustules or tubercles; and beyond these the surface is minutely pustulose, the vascular impressions becoming distinct towards the margin. The cardinal process is divided from the base, the divisions strongly diverging.

The varieties of form and gradations of size usually observed in this species are illustrated on Plate XVII. In the greater proportion of New-York specimens, the hinge-line is usually extended very little, if at all, beyond the width of the shell below; but in the western specimens, figs. 2 *h* and 2 *i*, the extremities are much produced. In these specimens the striæ do not diminish towards the margin, as in those from more eastern localities.

In figure 2 *r* the area is purposely broken away to show the extent of the occlusor muscular impressions. The absence of foramen, or callosity marking its place, is shown in several of the figures.

Beginning its existence in the Schoharie grit, this species there attains its full size; but its muscular markings are rarely well developed in the specimens from that rock, probably owing to the tenuity of the shells.

In the Corniferous limestone, the specimens (as far as they have come under my observation) do not reach the full dimensions of the species, but are thick and robust, having a high degree of convexity.

It is common and even abundant in many localities of the Hamilton group, where it reaches a perfection and degree of development not elsewhere observed. In the eastern part of New-York, in the arenaceous portions of the group, it is usually seen in the condition of casts of the interior; and its more perfect development is in the calcareous shales beyond the Genesee valley. In Illinois and Iowa, in the calcareous shale of the same horizon, it is abundant. It occurs in the Chemung group at several localities in Western New-York, but is by no means a conspicuous fossil.

Geological formations and localities. This species is found (as already observed) in the Schoharie grit, Corniferous limestone, Hamilton and Chemung groups. In the Hamilton group, some of the principal localities are Darien in Genesee county, and Eighteen-mile creek in Erie county; likewise on Seneca and Cayuga lakes, and at some more eastern localities.

It has been found in the same horizon in Pennsylvania, Maryland and Virginia; at Rock island (Illinois), New-Buffalo and Pine creek (Iowa).

Strophodonta nacrea.

PLATE XVIII.

Strophomena (Strophodonta) nacrea : Hall, in Tenth Regents' Report on State Cabinet, p. 144. 1857.
Strophomena lepida : Hall, Geol. Report Iowa, Vol. i, part 2, pa. 493, pl. 3, f. 3 *a*, *b*, *c*. 1858.

Shell small, semielliptical, having a brilliant nacreous lustre*: hinge-line crenulated, equalling or a little less than the greatest width of the shell below, and sometimes terminating in more or less distinct angles. Dorsal valve concave. Ventral valve sometimes regularly convex, flattened at the margins, often depressed-convex in the umbonal region and abruptly arched towards the front : beak very small and depressed: area very narrow, linear, without foramen. The area of the dorsal valve is often nearly as wide as that of the ventral valve.

Surface apparently smooth, but under a lens showing very faint concentric lines of growth, with sometimes obscure traces of radiating lines.

The muscular impressions in the ventral valve extend more than half the length of the shell. The divaricator muscular imprints are deeply

* The shell has often a brownish or coppery metallic lustre, probably owing to the staining of the surface from the decomposition of iron pyrites.

depressed, elongate-ovate, narrowing above and somewhat widely separated below; while the occlusor impressions are narrow-ovate spots on the thickened portion of the shell, and below these extends a narrow elevated band separating the other impressions. In the dorsal valve, the anterior and posterior occlusor muscular impressions are small and not strongly defined. The cardinal process is slender, bifurcating, with a narrow rounded ridge extending from its base down the middle of the valve. The interior of the shell, excepting the muscular impressions, is studded with prominent scattered granules or papillæ. The crenulations on the hinge-line are rather distant, but conspicuous.

Even in fragments this species may be always distinguished from its associates by the peculiar lustre.

This species bears some resemblance to *Orthis lepis* of Bronn, but is much less distinctly striated than well-preserved specimens of that shell, and the crenulations of the hinge-line are only about half as many as in the European species. The generally smooth surface and strong lustre of the two, in specimens before me, give a similarity in external appearance, which is not confirmed by a comparison of the details. Observations of a larger number of specimens has shown that there are no constant characters by which the New-York and Iowa forms can be separated from each other, and the *S. lepida* therefore becomes a synonym.

Geological formations and localities. In the shales of the Hamilton group on the shore of Lake Erie, at Darien, York, and on the shore of Canandaigua lake. It occurs in the same formation at Rock island, in Illinois; and is cited by Mr. Billings as having been found in the Hamilton shales in the town of Bosanquet in Canada West. It also occurs in the Corniferous limestone at East-Victor and at Lapham's mills in Ontario county, New-York.

Strophodonta inequistriata.

PLATE XVIII.

Strophomena inequistriata : Conrad, Jour. Acad. Nat. Sciences, Philadelphia, 1842, Vol viii, pa. 254, pl. 14, f. 2.

Strophomena inequistriata : Hall, Geol. Rep. 4th District, 1843, p. 290, f. 4.

Compare *Orthis interstrialis* : Phillips, Pal. Fossils, 1839, pa. 61, pl. 25, f. 103 *a*, *b*, *c*. *d*.

Strophomena (*Strophodonta*) *inequistriata* : Hall, in Tenth Report on the State Cabinet, p. 142. 1857.

Shell semioval or somewhat semicircular in outline : hinge-line extended beyond the width of the shell below; extremities acute, sometimes auriculate. Rarely the sides are nearly straight below the auriculate extremities, and the basal curve rather straightened on each side and produced in a subnasute extension in the middle.

Ventral valve usually regularly convex, and often more gibbous in the middle and abruptly arched towards the hinge-line, depressed-convex on the disc, with the margin towards the front more abruptly curving; sometimes gently sloping towards the front and abruptly constricted on the sides below the cardinal extremities, which are deflected to the ventral side : the beak is small, scarcely prominent on the hinge-line. Dorsal valve moderately concave, often more deeply concave; sometimes moderately concave in the upper and middle part, and suddenly deflected towards the front.

Area of the ventral valve narrow-linear, extending to the extremities of the hinge-line, striate vertically, with the inner margins crenulate from one-half to two-thirds the length from the beak to the extremities : foramen none; a slight linear elevation extends across the area. Dorsal area scarcely more than half as wide as the ventral area, and, in very perfect specimens, having a narrow elevated ridge crossing it in continuation of that of the opposite valve.

Surface of the entire shell marked by slender distant elevated striæ, which are increased by interstitial additions; the interspaces occupied by much finer closely arranged striæ, which are scarcely visible to the naked eye, and crossed by fine concentric striæ.

In the interior of the ventral valve, the occlusor muscular impressions occupy a narrow subquadrangular elevated space just beneath the apex; while the divaricator muscular imprints occupy a short broad space on each side, and are limited by nearly vertical or slightly curving ridges which have in some degree the appearance of dental lamellæ : within the limits of these ridges, the muscular imprints are not strongly marked. In the dorsal valve, the posterior occlusor imprints are broad and extending far towards the cardinal line, and often limited externally by a low pustulose ridge : the anterior impressions are small and narrow, separated by a narrow mesial ridge and margined by diverging elevated ridges, which, above the impression, are united in the mesial ridge from which proceeds the bifurcating cardinal process : the divisions of this process are broad and somewhat flattened vertically or a little obliquely, and sometimes grooved on the inner side and distinctly bilobed at the extremities.

The condition of the muscular imprints is subject to considerable variation; for in some specimens those of the anterior occlusors are raised in two prominent processes to a height greater than the enclosing ridges, and sometimes the imprints remain depressed, and the enclosing ridges are extremely elevated, arching over and nearly enclosing the muscular area. Just without the muscular areas, in both valves, the interior surface is rather strongly pustulose, and beyond this it is finely pustulose in lines corresponding to the external striæ; while the dorsal valve, more often than the ventral, is marked by strong vascular impressions.

This species bears such a close resemblance to the figures of Prof. Phillips cited above, that in my Report of the Fourth Geological District of New-York I regarded the two as identical. I am now disposed to doubt the propriety of this reference. It varies much in the convexity of the ventral valve; being in some individuals extremely gibbous, and in others very moderately convex. The area is subject to some variations in width, perhaps owing to compression; and in some specimens, the area of the dorsal valve is nearly as wide as the ventral area.

The general surface character of the convex valve is much like that of good specimens of *Strophomena alternata* of the Trenton limestone, but it does not

appear to be subject to such extreme variations in respect to the striæ. It resembles very closely, in its surface markings, the *S. textilis*, but is always smaller, with a more extended hinge-line, and never so flat as that species. In the same respects it is not very dissimilar to some of the other species of the Upper Helderberg and Hamilton groups; and it has been confounded with *S. inequiradiata*, which is a much larger shell, with different internal characters. Its surface striæ are more delicate than any of the other species, and its muscular impressions are peculiar in form and details, and entirely unlike those of any other species, as shown in figures 2 *h*, *i*, *k*, on Plate XVIII.

The general characters of the species and varieties of form are shown in figures 2 *a*–*k*, on Plate XVIII.

After critical comparison of all the other species of the Hamilton group, I am convinced that the species of Mr. CONRAD is the one I have here described and illustrated, although not entirely corresponding with the original description.

Geological formations and localities. This species occurs in the Corniferous limestone somewhat rarely, but is common in the Hamilton group, and is at present unknown in any higher position. It is common in localities along the shores of Seneca, Cayuga and Canandaigua lakes; at Moscow; York; Pavilion; Darien; Eighteen-mile creek, and numerous other places in the Hamilton group. Its localities in the Corniferous limestone have already been enumerated on page 88.

Strophodonta textilis.

PLATE XVIII.

Strophomena (Strophodonta) textilis : HALL, in Tenth Report on State Cabinet, p. 141. 1847.

SHELL very thin, nearly flat, transverse, semioval, sometimes nearly as long as wide, the length being from two-thirds to four-fifths the width; hinge-line equalling or sometimes a little greater than the width of the shell below, with salient angles.

VENTRAL valve slightly convex. Dorsal valve gently concave.

AREA of the ventral valve narrow, almost linear, and extremely narrow towards the extremities, vertically striated, with a narrow callosity in the centre; the inner margin crenulate for about two-thirds its length. Area of the dorsal valve linear, scarcely half as wide in the middle as that of the opposite valve.

Surface marked by distant slender, elevated radiating striæ, which are increased by interstitial additions; and the interspaces are marked by five, six or more extremely fine striæ, which are cancellated by finer concentric striæ. There is apparently no essential difference in the surface markings of the two valves.

In the ventral valve, the occlusor muscular impressions occupy very narrow spaces just beneath the beak : the divaricator muscular impressions are large flabelliform, each one divided into several lobes, and margined on each side for a part of their extent by a pustulose ridge; while the anterior limits are not usually well defined. In the dorsal valve, the posterior occlusor imprints are large semioval and concave, defined by a slight thickening of the shell, and separated by a rounded mesial ridge which divides below; the marks of the anterior occlusors being at the lower extremities of this divided ridge. The cardinal process is bifurcate from its origin, and comparatively slender.

The interior surface, beyond the muscular impressions, is marked by somewhat distant minute elongate papillæ which are arranged in lines in the direction of the striæ. The interior of a single dorsal valve shows also prominent radiating folds; but this feature may not be constant.

This species may be readily distinguished by its nearly flat form and large size. The surface striæ are similar to those of *S. inequistriata*, and to those of the dorsal valve of *S. concava* and of *S. inequiradiata*. The muscular impressions of the ventral valve are similar to those of the *S. perplana;* but the interior of the dorsal valve of that species exhibits a shorter cardinal process, and a different disposition of the muscular impressions. The latter are very similar to those of the dorsal valve of *S. inequistriata*, as is shown in figures 2 *h* and *d* of Plate XVIII; while there is a great contrast in the ventral valves of the two species, as shown in the cast of *S. textilis*, figure 4, and the interior of *S. inequistriata*, figure 2 *k* of the same plate.

Figures 3 *a*, *b*, *c*, of Plate XVIII illustrate the usual forms of the species; while figure 4 is unusually extended on the hinge-line.

Some farther illustrations of the interior are given upon Plate XIX A.

Geological formations and localities. This species is known in the Hamilton group on the shores of Seneca and Cayuga lakes; Mud creek and West-Bloomfield, Ontario county; York and Moscow, Livingston county; Bethany, Covington and Darien, Genesee county; and the shore of Lake Erie. It occurs also in the Tully limestone; and a single dorsal valve has been seen from the Corniferous limestone.

STROPHODONTÆ OF THE CHEMUNG GROUP.

Strophodonta cayuta (n. s.).

PLATE XIX.

Referred to *S. interstrialis* of PHILLIPS, Geol. Rep. 4th District New-York, p. 266. 1843.

SHELL semielleptical; length and breadth about as three to five, while in some specimens the length is nearly equal to the width; sometimes the width on the hinge-line is twice as great as the length: cardinal extremities usually more or less produced, and often auriculate.

VENTRAL valve usually of moderate convexity, sometimes but slightly convex on the upper half of its length, and abruptly inflected towards the front; while there is frequently a longitudinal ridge down the middle. In the shaly beds, this valve is compressed and only gently convex. The dorsal valve is usually very gently concave.

AREA of the ventral valve narrow-linear, and the inner margin crenulated for more than half its length. The dorsal area is barely a crenulated line.

SURFACE marked by distant sharp elevated striæ, between which are four, five, six or more extremely fine striæ, which are increased by interstitial additions.

The interior of the ventral valve, as shown in casts, is marked by a broad bilobed divaricator muscular impression, which is wider than long, spreading from the apex, and surrounded by an elevated rim. The occlusor muscular impressions are minute spots just below the apex of the umbonal cavity. The divisions of the muscular impression are deeply striated in the cast, and often show subordinate lobes near the margin. The surface around the muscular impressions is papillose.

This species bears much resemblance to *S. inequistriata* of the Hamilton group in its external characters, but the ventral valve is not so regularly convex, and the dorsal valve is less concave; while in the muscular impressions it differs conspicuously. In the coarser sandstones of the Chemung group, the specimens of this shell are usually smaller and more convex; while the striæ are not so regular and even as in those from the more shaly portions of the formation. It is scarcely

known except in the condition of casts, the shell being rarely preserved in any of the specimens obtained.

The figures 1–5 on Plate XIX show the ordinary forms of casts of the ventral valve; no casts of dorsal valves in a condition to be illustrated, have been found up to this time.

Geological formation and localities. In the Chemung group, on Cayuta creek; near Elmira; along the line of the Blossburgh railroad; near Bath in Steuben county, and in other localities in the southern counties of the State.

Strophodonta mucronata.

PLATE XIX A.

Strophodonta mucronata : CONRAD, Jour. Acad. Nat. Sciences, Philadelphia, Vol. viii, p. 257. 1842.

The description of Mr. CONRAD is as follows : —

" WINGED : inferior valve convex-depressed, with crowded unequal " radii, and very fine transverse wrinkles; umbo flattened; apex on " a line with the hinge-margin; hinge extremities acutely angulated."

The species which I have identified with this one is a semioval shell, the proportions of length and breadth varying considerably, the hinge-line often extended beyond the width of the shell. The ventral valve is very depressed-convex, and the dorsal valve nearly flat. The area of the ventral valve is extremely narrow, and the inner margin crenulated for about half its length. The surface is marked by distant sharp elevated striæ, with the interspaces occupied by numerous finer undulating striæ. The muscular impressions are faintly marked; those of the occlusor muscles occupy a minute space near the apex of the cast; and the divaricator muscular impressions are elongate and spreading, and partially limited by an oblique pustulose ridge on each side, in form and character like those in *S. perplana*, but less strongly defined. The cardinal process of the dorsal valve is slender, and supported at its base by an oblique ridge on each side, between which the muscular markings are faintly impressed.

This shell has the general form and the tenuity of *S. perplana;* but the muscular markings are not proportionally as large in the ventral valve, and the cardinal process of the dorsal valve is much more slender and less diverging. The surface

striæ are of the character of *S. inequistriata*, *S. textilis* and others, a condition sometimes assumed by *S. perplana* in the Hamilton shales of Iowa; but we have that species in the same association with this one, showing its characteristic muscular impressions, with a somewhat wider area than *S. mucronata*, and the surface striæ even or raised at intervals into elongate nodes, but never having the elevated striæ and equal interspaces with finer striæ shown by this species.

Although it is not always (and in some localities not often) produced at the hinge-extremities, it is the only form which I can identify with Mr. CONRAD's description. The *S. elmira* is too convex on the ventral valve, and moreover rarely occurs except in casts which give the strong muscular impression a prominence that would not have been overlooked in the description.

Figures 5 and 5 *a*, Report (p. 266) of the 4th District of New-York, are of this species, and not identical with 5 *b*, *c*, which are of the *S. cayuta*.

The figure given by Mr. VANUXEM (Geol. Report of the 3d District, page 174, figure 1) is of this species, found in the neighborhood of Ithaca.

Geological formation and localities. In the Chemung group, at Chemung-narrows; at the Inclined plane of the railroad near Ithaca; near Elmira and Bath; and also at Cortlandville and many other localities in the central and southern parts of the State.

Strophodonta cœlata (n. s.).

PLATE XIX.

SHELL resupinate, semielliptical or semicircular; the cardinal extremities extremely produced.

THE cast shows that the ventral valve is concave, being moderately convex upon the umbo, and sloping gently downwards to below the middle; beyond which, the anterior portion is abruptly deflected.

The area is of moderate width, flat and striated, with the margin crenulated for nearly its entire length; the crenulations elongate and a little oblique.

The divaricator muscular impressions form a broad flabelliform scar, which is once and a half as wide as long, and has been nearly surrounded by an elevated rim. Each division is marked by eight or nine distinct lobes. The occlusor impressions occupy semioval spots in the upper part of this area, and are separated by a narrow ridge, which becomes broader

above and is truncate at its extremities. Outside of the muscular impression, the surface is punctate or papillose; and from the commencement of the abrupt curvature, it is marked by strong vascular impressions. The cast of a convex dorsal valve found in the same strata shows the marks of a strong nearly vertical cardinal process, with remains of socket plates and strong impressions of the occlusor muscles.

Since we know but this species in the Chemung group with a concave ventral valve, it is inferred that the convex dorsal valve may belong to the same species.

The specimens are illustrated in figures 7 and 8 of Plate XIX.

Geological formation and locality. In some arenaceous beds of the Chemung group, to the northwest of Elmira.

Strophodonta perplana *var.* nervosa.

PLATE XIX.

Strophomena nervosa : HALL, Geol. Report of 4th District, p. 266, f. 1.
Strophomena delthyris : CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. viii, pa. 258, pl. 14, f. 19.

SHELL very depressed, subplano-convex; semielliptical, with hinge-extremities often extremely produced.

VENTRAL valve very slightly convex; and dorsal valve barely concave.

SURFACE marked by sharp elevated undulating striæ, which are irregularly bifurcated, and often swelling at unequal intervals into node-like expansions.

The casts, as far as observed, are undistinguishable in character from those of *S. perplana.*

In describing from the general form of the shell and surface characters, no one would suspect this to be of the same species as the regularly striated *S. perplana* of the Hamilton group and Corniferous limestone. A comparison of numerous imperfect specimens retaining some portion of the shell, as shown in figures 15 and 16, together with casts of the interior of the same, has left no doubt as to the propriery of referring them to *S. perplana.*

Figure 14 is from the original specimen of *S. nervosa*, and is a cast of the ventral valve in soft olive shalo; whilo figure 15 is part of a specimen retaining the shell essentially entire.

The casts figures 17, 18 and 19 preserve the usual characters of the casts of the ventral valve of *S. perplana;* the marks of striæ, as far as seen, being more regular than those of the shell figure 15. These casts I infer to be similar to the specimen from which Mr. Conrad described *Strophomena delthyris*, loc. cit.

Geological formation and localities. These specimens present the usual aspects of this species and variety in the Chemung group in Tioga county; near Ithaca, and along the line of the Corning and Blossburgh railroad. The more characteristic forms of those designated *S. nervosa* were found near Bath, and at Campbelltown in Steuben county.

Strophodonta demissa.

PLATE XIX.

[Described page 101 of this volume, Hamilton group.]

The condition of this species, in the Chemung group, is illustrated in figures 8–12. Figure 8 is a somewhat distorted cast of a ventral valve which shows no muscular markings. Figure 10 is a similar cast, a little more extended on the hinge-line; while figure 9 is extremely extended at the cardinal extremities. Figures 11 and 12 are views of a cast of a ventral valve scarcely differing in condition from the better preserved specimens in the Hamilton group.

The casts and impressions of this shell in the Chemung group frequently show broad radiating folds, as partially illustrated in figure 9; and the central portion is often produced into a nasute extension.

Geological formation and localities. This species occurs on Chemung creek and at Chemung-narrows; also near Jefferson in Steuben (Schuyler) county, and near Bath; and in Cattaraugus and Chautauque counties.

Strophodonta subdemissa.

The species described by me as *Strophomena* (*Strophodonta*) *subdemissa*, in the Tenth Report on the State Cabinet, is only a variety of the *S. demissa*, as I suggested at the time. The conditions existing in the specimens then examined have been found in a greater or less degree, and connected with other modifications, in nearly all the specimens from Illinois and Iowa.

Strophodonta plicata.

Strophodonta plicata : Hall, Thirteenth Report on the State Cabinet, p. 90. 1860.

This species, which was founded on a well marked specimen from rocks of the age of the Hamilton group at Iowa city, has been obtained at Independence, Iowa, and a specimen kindly forwarded to me by Mr. Orestes St.John.

Genus Chonetes (Fischer, 1837).

The Genus Chonetes, having the general form of Strophodonta or Strophomena and Leptæna, is distinguished externally from those forms by the tubular spines on the outer margin of the ventral area; and from Productus by the manner in which these spines are disposed. In some species, however, in addition to these, the surface of the shell is studded with small spines as in Productus. Internally it has been shown by Mr. Davidson to possess characters which ally it with Productus; and it connects more nearly, by form and general features, the families of Strophomenidæ and Productidæ.

In the ventral valve, the area is narrow but well-defined, with a distinct foramen which is partially closed by a pseudo-deltidium, and the remainder of the space is filled by a cardinal process from the opposite valve. In the bottom of the cavity there is a longitudinal median ridge, and on each side and close to it are the occlusor muscular impressions: the divaricator impressions occupy a wider space, and usually are not very well defined in their limits, though having the same general form and features as those of Strophodonta.

In the dorsal valve, the teeth-sockets are well marked. The cardinal process is entirely unlike that of the preceding genera, being simple at its base, and bifid or grooved at the extremity; while the lateral divisions usually reach nearly as far as the central portion of the process, and are separated from that by a groove more or less distinct. Sometimes the lateral or accessory lobes are distant from the extremity, and separated in like manner by a groove.

In one or more of the slender forms of the process, these lateral lobes are situated at some distance from the apex, and appear like minute processes on the sides. At its base, the cardinal process is continued in a slender median ridge. The double occlusor impressions are small, and from between them proceeds an elevated vascular marking which assumes a reniform shape; this being a distinguishing feature of the genus, which allies it with Productus.

The interior of the shells are strongly pustulose or papillose : the little granules are arranged in the direction of the striæ and along the grooves of the exterior striæ, which often become defined elevations upon the inner surface of the shell.

So far as we at present know the species in the rocks of this country, the genus begins its existence in the shales of the Clinton group, where a single species has been found. There is no species known in the Lower Helderberg group, and but a single one in the Oriskany sandstone. Two species are known in the Schoharie grit, and three others are common in the Corniferous limestone ; while others are added to the number in the Hamilton and Chemung groups. Several species are known in the Carboniferous limestones and in the Coal measures.

For the most part the species are of small size, and, when well preserved, it is not very difficult to distinguish them; but in their various conditions of preservation, such as partially exfoliated and more or less worn shells, casts of the interior and impressions of the exterior, in a matrix varying from pure limestone to calcareous shale, and through the arenaceous shales to a nearly pure sandstone, the specific relations often become difficult of determination.

In a very large proportion of the specimens coming before me for investigation, the cardinal spines cannot be seen, or are but imperfectly preserved. Their comparative strength or direction often furnishes means for specific distinction; but I have not been able to satisfy myself that the number of spines on the hinge-line is of specific importance, for these are sometimes unequal on the two sides of the apex, and their development seems often to be promoted or retarded by the irregular growth of the shell. The number of these appendages does not depend on the size of the shell; some of the larger species having only three or four spines on each side of the beak, while in the smallest specimens of the group in our rocks (*C. lepida*), I am able to count six spines on each side ; and in *C. scitula*, as many as six or seven, the bases only of many of them being preserved in the substance of the shell as tubular openings.

In many specimens the spines can be seen to originate near the inner margin of the area, or along the hinge-line, and can be traced in the substance of the shell in an oblique direction inwards, at first nearly parallel with the margins of the foramen; and it is only after becoming free, that they take a vertical or obliquely outward direction.

The nature of these tubes penetrating the substance of the shell, has been pointed out by Count Von Keyserling*, and shown in his illustrations of *Chonetes comoides;* but this function has been doubted by Prof. De Koninck, who regards their obliquely inward direction as a contrary indication.† In many of our specimens, however, I am able to trace these tubes through the substance of the shell from the hinge-margin (their opening into the interior being a little within the margin), beginning near the triangular foramen, and penetrating the shell to the upper edge of the area in lines parallel to the sides of the foramen. Those nearest the centre are more closely arranged than those at a greater distance : the former appear on the exterior as minute pustules, sometimes very close to the apex of the shell; and in receding from the centre, they become more prominent, and attain the character of spines. In some examples, the obliquity of the tubes within the substance of the shell is seen to become less and less on receding from the apex, and they are often curved outwards before reaching the surface; but the connexion of these tubes with the spines is unmistakable.

In numerous examples of the casts left by the destruction of the ventral valve, the form of the tubes is well preserved in the infiltrated matter; and in these casts we often find evidence of the tubes near the centre, where no spines are visible on the exterior surface of the shells of the species, as in *Chonetes logani* and *C. scitula.*

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* Geognostiche Beobachtungen auf einer Reise in das Petschora-land : By Count Alexander Von Keyserling, 1846.

† "These grooves do not appear to me to be produced by the cardinal tubes, as Mr. De Keyserling thinks, because in this case they should take an opposite direction : I am led to believe that they depend solely on the successive growth of the shell." Recherces sur les Animaux Fossiles, p. 190.

CHONETES OF THE UPPER HELDERBERG AND HAMILTON GROUPS.

Chonetes hemispherica.

PLATE XX. FIG. 6.

Chonetes hemispherica : HALL, Tenth Report on State Cabinet, p. 116. 1857.
Compare *Strophomena gibbosa*, CONRAD in Annual Geol. Report, 1841, p. 54.

SHELL transverse, semielliptical or somewhat semicircular, the greatest width being on the hinge-line, which is often much extended and conically auriculate at the extremities.

VENTRAL valve very ventricose or subhemispheric, excluding the extremities; the umbo prominent, rising considerably above the hinge-line, with the apex incurved. The hinge-line is marked by three, four or more spines on each side of the middle.

DORSAL valve unknown.

SURFACE marked by numerous regular rounded striæ, some of which bifurcate near their origin and then continue simple throughout their length; a few bifurcate on the middle of the shell, and near the margin there are sometimes intercalations of other striæ.

The cast of the ventral valve preserves the striæ with almost the same distinctness as the exterior shell; and the depressions between them are marked by distant oblong pores, which indicate papillæ of the same form on the interior of the shell.

In a specimen of ordinary size, there are about 50 to 54 rounded striæ, and 7 to 9 (and rarely 12 or 14 in young specimens) in the space of two-tenths of an inch, so few of which bifurcate that the general aspect is that of simple striæ.

Some specimens, which appear to be younger individuals of this species, are of moderate convexity, and the striæ are finer and a little more angular than in the larger and older specimens.

The figures 6 *a*, *b*, represent the ordinary forms of this species.

The description of *Strophomena gibbosa*, given by Mr. CONRAD, is as follows : "Subtrigonal; inferior valve with back and umbo very prominent and the sides "compressed; surface with numerous equal slightly undulated striæ which "bifurcate on the umbo; hinge-extremities prominent and angulated. *Locality* : "Helderberg, in Onondaga limestone."

The striæ in *C. hemispherica* are not undulated, and they rarely bifurcate on the umbo.

Geological formation and locality. In the Schoharie grit, in the Helderberg mountains and at Schoharie, and rarely in the Corniferous limestone.

Chonetes arcuata.

PLATE XX.

Chonetes arcuata : HALL, Tenth Report on the State Cabinet, p. 116. 1857.

SHELL semielliptical or approaching to semicircular; the cardinal extremities often extended and auriculate.

VENTRAL valve arcuate, extremely gibbous or ventricose, with usually a shallow undefined longitudinal sinus extending from the umbo to below the middle or near the front of the shell, often constricted near the cardinal extremities : umbo more or less gibbous, and raised in a gentle elevation above the hinge-line, with the beak incurved. Hinge-line, in casts, apparently crenulate; and on the exterior margin are ten or twelve tubular spines, directed obliquely outwards.

DORSAL valve profoundly concave, following nearly the convexity of the opposite valve, and having the centre a little elevated, corresponding to the mesial depression.

SURFACE marked by fine even rounded striæ, which increase both by bifurcation and intercalation, crossed by extremely fine concentric striæ, with sometimes stronger subimbricating lines of growth.

The surface of the cast in the ventral valve is marked by closely disposed oblong pits or pores, from the papillose inner surface of the shell. There is a constricted line extending from the apex, gently receding from the hinge-margin and curving inwards at some distance from the cardinal extremities, and thence to the front of the shell, leaving the portion outside of this a little more elevated.

The muscular impressions consist of a narrow central scar just below the apex of the beak, for the occlusor muscles, with a central elongate oval scar marking the place of the divaricator muscles; while there are two elongate ovate or pyriform scars, one on each side of the apex, and spreading laterally just within the limit of the constricted line, figure 7*f*.

The figures 7 *a*–*f* illustrate the usual form and convexity of the species. The character of the cast of the ventral valve is shown in figures 7 *e*, *f*, where the marks of the internal tubes of the area are conspicuous.

The cardinal spines are rarely visible, owing to the incurved margin which usually leaves these appendages imbedded in the stone. In one specimen, however, five or six spines are seen on one side of the apex. The shell of the area is penetrated from the interior by numerous comparatively large cylindrical tubes, some of which terminate in elongate spines upon the exterior margin. In one specimen, fifteen of these tubes may be counted on one side of the apex. In the casts or partial casts of the shell, these tubes give the appearance of coarse crenulations.

This species is distinguished from *C. hemispherica* by being a little less prominent on the umbo, and by the shallow sinus, as well as the more numerous and much finer striæ. The cast does not preserve the marks of the striæ so conspicuously, while the surface is more abundantly pitted, without being sensibly arranged in distinct lines.

Geological formation and locality. This species has been found only in the Corniferous limestone, near Williamsville and Clarence-hollow in Erie county, N. Y.

Chonetes acutiradiata.

PLATE XX.

Strophomena acutiradiata : Hall, Geol. Report 4th District New York, p. 171. 1843.
Chonetes acutiradiata : Hall in Tenth Report on the State Cabinet, p. 117. 1857.

Shell nearly semicircular, sometimes a little more than twice as wide as long; the cardinal extremities produced.

Ventral valve moderately convex, sometimes a little gibbous in the upper part, and frequently flattened or depressed at and below the middle : umbo little elevated above the hinge-line; greatest convexity above the middle, from whence it curves gently to the front, somewhat abruptly depressed towards the cardinal extremities, which are subauriculate and nearly flat. In two individuals, there is a distinct longitudinal sinus in the middle of the valve.

Dorsal valve unknown.

Surface marked by regular subequal rounded or subangular striæ, which are often irregularly bifurcated towards the margin or increased by intercalations, and sometimes are nearly simple throughout their length below the umbo, those of the cardinal extremities being very irregular or nearly obsolete. Hinge-line marked on each side of the centre by four or five strong tubular spines which are directed obliquely outwards.

The sinus in the ventral valve is not uniform, and though evidently a normal character where it occurs, it cannot be relied upon for characterising the species.

This species resembles the *C. hemispherica;* but the form of all the specimens is nearly semicircular, the cardinal extremities nearly flat, and it is never so gibbous on the umbo, while the striæ are finer and the cardinal spines more oblique.

In the surface markings, this species is more nearly like *C. coronata*, but its form in the specimens known is quite distinctive.

Geological formation and locality. In the Corniferous limestone, near Williamsville; Clarence-hollow; and Stafford, New-York; and in the same limestone at the Falls of the Ohio.

Chonetes lineata.

PLATE XX.

Strophomena lineata : Vanuxem, Geol. Report of the 3d District New-York, p. 139. f. 6. (The figure 6 is placed by mistake at the side of a section of Ichthyodorulite, f. 7.)

Chonetes glabra : Hall In Tenth Report on the State Cabinet, p. 117. 1857.

Compare *Strophomena crebristriata*, Conrad, Jour. Acad. Nat. Sciences, Philadelphia, Vol. viii, pa. 254, pl. 14; f. 3.

Also *Chonetes scitula*, Tenth Report on the State Cabinet, p. 147.

Also *Strophomena lineata*, Conrad, Annu l Report, 1839, p. 64.

Shell subhemispheric, semioval in outline, with the cardinal line equalling or greater than the greatest width of the shell below.

Ventral valve very convex, often ventricose, a little flattened in the middle, regularly curving to the front and lower lateral margins, more abruptly depressed at the sides, with the cardinal angles somewhat flattened and often a little deflected to the ventral side.

Dorsal valve concave, the concavity less than the convexity of the opposite valve. The area is narrow, that of the dorsal valve being a bare line : the ventral area is twice as wide in the middle as near the extremities. Cardinal spines small, and usually but slightly oblique to the hinge-line, rarely more than two or three visible on each side of the beak.

Surface marked by numerous slightly elevated rounded striæ, a few of which are more prominent near the beak, and increase by bifurcation and intercalation till the number on the margin becomes from fifty-four to sixty or more. The striæ towards the cardinal angles are less conspicuous, and sometimes from exfoliation are not at all visible. The entire surface in well preserved specimens is marked by extremely fine concentric striæ.

The cast is a little constricted within a line about two-thirds the length from the beak, the middle being more gibbous, while it is a little expanded beyond this line. The surface of the cast is punctate, moderately marked by striæ, becoming more strongly marked at the constriction and from thence to the margin. The interior of the valve preserves similar markings, the surface being papillose or pustulose. The muscular impressions of the ventral valve are sometimes defined, and there is a median longitudinal ridge. The interior of the dorsal valve is pustulose in lines corresponding to the striæ. The muscular impressions and base of cardinal process are not defined in any specimens observed.

After an examination of a large number of individuals, I find the variation in number of striæ too great to offer any reliable character for specific distinction.

The species is doubtless the one figured by Mr. Vanuxem (loc. cit.); and I am disposed to believe that the *Strophomena crebristriata** and *S. lineata* of Conrad (loc. cit.) may be the same species. It is most nearly allied to *C. yandellana*, and may perhaps be regarded as identical with that species. There are, however, certain differences which are constant in all the specimens examined. The *C. lineata* is always more gibbous (See figs. 3*f* and 4 *d*, Plate 20): in *C. yandellana* the cavity of the ventral valve is more regularly concave, and less distinctly constricted

* I have already referred with doubt a species from the Schoharie grit to *S. crebristriata* of Conrad ; but since that description has been printed, I have had reason to question the correctness of my reference. It is impossible to determine positively the species to which some of these descriptions refer.

than in *C. lineata*. In the dorsal valve of the former, the muscular impression, base of cardinal process, etc. are strongly defined, while they are not so in *C. lineata*.

This species differs from *C. pusilla* in its much finer and more numerous striæ; while it is smaller and more rotund than *C. scitula* of the Hamilton group.

The characters of the species are illustrated in figures 3 *a–f*, on Plate XX.

Geological formation and localities. In the Corniferous limestone at Oneida falls, and abundant between Jamesville and Manlius in Onondaga county, and in the north part of Seneca county. It is less abundant in the eastern localities of the Corniferous limestone, and also in the extreme western localities; but it has been found on the Indian Reservation near Buffalo.

Chonetes yandellana.

PLATE XX.

Chonetes yandellana : HALL in Tenth Report on the State Cabinet, p. 118. 1857.
Compare *C. lineata*, ut sup. page 121.

SHELL semioval, more or less gibbous : hinge-line equalling the greatest width of the shell.

VENTRAL valve regularly convex, abruptly depressed towards the cardinal angles, which are nearly flat and very slightly deflected to the ventral side.

DORSAL valve with the concavity a little less than the convexity of the opposite valve.

AREA of the ventral valve parallel with the longitudinal axis of the shell, nearly twice as wide in the middle as near the extremities : foramen comparatively large, with margins projecting, and the opening filled by the cardinal process of the opposite valve. Dorsal area extremely narrow, being barely a defined line.

SURFACE marked by fine somewhat equal striæ, which increase by bifurcation and intercalation till there are from sixty to seventy on the margin of the shell. The cardinal margin of the ventral valve bears three or four short oblique spines on each side of the centre.

The interior of the ventral valve shows strong dental lamellæ, and the muscular impressions are pretty well defined. The dorsal muscular

impressions are well defined, and between them there is a strong mesial ridge which is extended in a bidentate cardinal process. The lower half of the surface is strongly papillose.

In general form, this species differs little from *C. lineata* (compare figures 3 *a–f* and 4 *a–g*, Plate 20). It is less gibbous, and not flattened on the middle of the ventral valve; while the interior presents more strongly defined markings. In a collection of more than twenty specimens entirely separated from the limestone, which were sent me by the kindness of Dr. JAMES KNAPP, of Louisville, Kentucky, the general form and moderate convexity are preserved, and it is rarely that more than three spines are seen on one side of the centre; but this feature is subject to variation, and the spines are sometimes unequal on the two sides of the same specimen.

All the differences indicated between this and the preceding species, I can readily believe may be produced in the same type by the different conditions of sea bottom, geographical distance, and other causes.

Geological formation and localities. In the hydraulic beds of the Corniferous limestone, at the Falls of the Ohio, Louisville (Kentucky), and Jeffersonville (Indiana).

Chonetes mucronata.

PLATES XX & XXI.

Strophomena mucronata : HALL, Geol. Report 4th District New-York, p. 180, f. 3. 1843.
Chonetes laticosta : HALL in Tenth Report on State Cabinet, p. 119. 1857.

SHELL small, semioval, moderately convex, nearly flat (often flattened in the shale and gibbous in the limestone) : cardinal line equalling or a little greater than the width of the shell below; the extremities sometimes salient.

In the original specimens of this species from the Marcellus shale, the ventral valve is slightly convex or nearly flat, one-fourth to one-third wider than long : the hinge-extremities are rarely a little produced, but the spines lying in the direction of the hinge-line often give it the appearance of extreme extension.

The dorsal valve is very moderately concave or nearly flat.

The surface is marked by twenty to twenty-four or twenty-six nearly simple subangular striæ, which are not so wide as the spaces between them. Sometimes one, two or three of these striæ are bifurcated towards

the margin. The radiating striæ are crossed by extremely fine concentric elevated striæ.

The cardinal margin shows two and rarely three spines on each side of the centre, which are abruptly bent outwards so as to lie nearly parallel to the hinge-line, and the outer one extending much beyond the cardinal extremity. The area is very narrow.

The figures 1 *a*–*g*, Plate XXI, are of this species from the Marcellus shale; the profile view is from a specimen which is much more convex than usual.

When destitute of the cardinal spines, this species resembles the young of *Tropidoleptus carinatus;* but is readily distinguished when the cardinal spines are present, and their direction is a characteristic feature of the species.

The shell described as *Chonetes laticosta* occurs in the Corniferous limestone and in the Hamilton group : the form is similar to *C. mucronata* of the Marcellus shale. The ventral valve is often quite gibbous, regularly rounded in the middle, suddenly depressed towards the cardinal angles, which are flattened and rarely extended beyond the width of the shell. The dorsal valve is moderately concave, sometimes very gently concave in the upper part of the valve and more abruptly curved towards the front.

The surface is marked by from twelve to twenty usually simple rounded or subangular striæ, a few of which bifurcate towards the margin, or are increased by intercalation of one, two or three others towards the margin, and have a greater or less space between them. This gives considerable variety of aspect to the surface; and in all the individuals in the limestone, the striæ are fewer and stronger than in those from the Marcellus shale. The specimens from the Hamilton group more nearly resemble those from the limestone.

The cardinal margin is marked by two or three spines on each side of the apex, with rarely indications of a fourth spine nearer the apex. These spines are bent abruptly downwards, and directed outwards almost parallel to the hinge-line, and in some instances the outer one appears to be a continuation of the cardinal extremity (see figures 1 *a*–*c*, Plate 20; and figure 1 *a*–*g*, Plate 21).

The area of the ventral valve is narrow and linear, and the dental lamellæ are prominent. In the interior there is a strong median angular ridge or septum reaching more than half the length of the valve. The dorsal area is scarcely more than the thickness of the shell. The cardinal process is narrow and scarcely bifid at the extremity, and is supported on each side at its base by an oblique ridge, and continued in a median longitudinal ridge.

The interior of both valves is strongly pustulose, but the muscular markings are not defined in the specimens examined.

In many of the smaller specimens from the Corniferous limestone, there are but from twelve to sixteen strong rounded striæ, and the ventral valve is very gibbous (figure 2, Plate 20). In some specimens the cardinal extremities are considerably produced, but this is not a common feature. The species is sometimes associated with *C. lineata* and *C. lepida* in the same fragment of stone. In the Hamilton group, it has been found more frequently in the harder semicalcareous beds.

The great variation in convexity, number of striæ and general aspect, leads me to suspect that the following (*C. deflecta*) may perhaps be only another phase of the same species.

Geological formation and localities. In the Corniferous limestone of Manchester, Ontario county; at Williamsville and Clarence-hollow; and on the Indian Reservation to the southeast of Buffalo in Erie county. These localities furnish the gibbous forms with strong striæ designated *C. laticosta.* In the Marcellus shale, the species is found at Avon in Livingston county, at Crooked creek near Darien in Genesee county, and at Alden in Erie county. It occurs in the Hamilton group at Pratt's falls, and in other localities in Onondaga and Madison counties.

Chonetes deflecta.

PLATE XXI.

Chonetes deflecta : Hall in Tenth Report on State Cabinet, p. 149. 1857.
Chonetes gibbosa : Id. Ibid. p. 145. 1847.

Shell semielliptical; length and width as four to five or eight to nine, but rarely proportionally wider.

Ventral valve extremely gibbous, regularly arched, the greatest elevation being about the middle of the length; abruptly depressed towards the cardinal angles, which are flattened, with the extremities deflected to the ventral side. The umbo is a little elevated above the cardinal margin, and the minute apex (in perfect specimens) projects a little over the area.

Dorsal valve deeply concave, but not equalling the convexity of the ventral valve.

Area of the ventral valve narrow, with the exterior margin declining in a gentle curve to the extremities : the triangular foramen is partially

closed by a pseudo-deltidium, and the aperture occupied by the cardinal process of the opposite valve. Dorsal area more than half as wide as the ventral, and marked in the middle by a wide triangular callosity.

Surface of the ventral valve marked by from twenty-six to thirty or thirty-four subangular or sometimes rounded striæ, which are often irregularly increased by bifurcation or intercalation towards the margin. In those with fewer striæ, they are sharper, more abruptly elevated, and only half as wide as the interspaces; while in those with a larger number, the striæ and interspaces are equal, but sometimes the striæ become fuller and more rounded, and the interspaces proportionally less in width. The striæ on the dorsal valve correspond essentially with those of the ventral valve, and there is a considerable space at the cardinal angles of each valve destitute of striæ. Fine closely arranged concentric striæ are visible on the surface of well-preserved specimens.

The interior of the dorsal valve shows a slender elongate cardinal process which is scarcely bifid at the extremity, and has on each side, a little below the apex, a minute lateral process for muscular attachment. The dental sockets are limited on the upper side by a narrow ridge, and on the lower side by a stronger oblique ridge which supports the base of the cardinal process. The two pairs of occlusor muscular imprints are distinctly marked; and outside of these, the vascular impressions are pretty well defined. Beyond the vascular impressions the surface is covered by elongate papillæ, the marks of the striæ being scarcely distinct.

The interior of the ventral valve shows strong dental lamellæ; a somewhat broad and angular median ridge terminates above the middle of the valve. The occlusor muscular impressions have not been observed; and those of the divaricator muscles are wide and spreading, but not distinctly defined. The cavity of the shell is abruptly rounded below, and the shell abruptly deflected at the sides, leaving the cardino-lateral margins nearly flat. The surface is finely pustulose in the middle, a little

more coarsely pustulose along the deflected line, and nearly or quite smooth towards the margins.

In the examination of a large number of specimens, the varieties are so extreme that it seems to me difficult to indicate reliable characters for separating this from *C. mucronata* or *C. laticosta;* the most distinctive feature being the finer striæ.

In the specimens referred to *C. deflecta* there are usually a larger number of striæ, and in some specimens nearly twice as many as the prevailing number in well marked specimens of *C. mucronata.* The area of the dorsal valve is likewise much wider in the former than in the latter; while the interior of the dorsal valve shows stronger muscular imprints, and the surface is not definitely marked by the striæ.

The original of *C. gibbosa* is a large very convex specimen, with numerous regular even rounded striæ (fig. 8 *b, c,* Plate 21), and is more extended on the hinge-line than the usual forms of *C. deflecta* (fig. 7 *a, b, c,* Plate 21).

The illustrations on Plate XXI, figures 7 *a–g* and 8 *a–c*, present the usual varieties of form observed in these shells.

Geological formation and localities. In the Hamilton group, on Canandaigua lake; and at Ludlowville and Kidder's ferry on Cayuga lake; at Moscow, York, Covington and other places in Western New-York.

Chonetes pusilla.

PLATE XXI.

Chonetes pusilla : HALL, Tenth Report on the State Cabinet, p. 149. 1857.
Compare *Chonetes deflecta* and *C. mucronata.*

SHELL small, semielliptical, the length and width being about as two to three; the hinge-line usually about equals the greatest width of the shell below.

VENTRAL valve gibbous, regularly convex on the umbo and in the middle and lower part of the shell, more abruptly depressed towards the hinge-extremities, which are obtuse and rarely a little extended : area narrow.

DORSAL valve with the concavity nearly corresponding to the convexity of the opposite valve : area linear, scarcely exceeding the thickness of the shell.

Surface marked by somewhat regular even rounded striæ, which are little elevated, and become obsolete on the cardinal margins : from twenty to thirty striæ may be counted on the margin of the shell, and in most of the individuals they are apparently simple throughout the greater part of their extent. In some specimens the striæ are conspicuously bifurcated, and also increased by interstitial additions. In well-preserved surfaces, fine crowded concentric striæ cross the radiating striæ. The cardinal margin exhibits bases of two or three and rarely four spines on each side, their extent or direction unknown.

Interior of the valves unknown.

This small Chonetes was referred by Messrs. Norwood and Pratten to *C. armata*, but it does not correspond with the figures and descriptions of De Koninck.

In general aspect of form, and convexity of the ventral valve, this species resembles *C. deflecta;* but all the specimens I possess are smaller, and the striæ more depressed. I am disposed to believe, however, that a larger collection of specimens from western localities may prove that this form is but another phase of the same species, induced by geographical and physical conditions, and that in reality the eastern and western forms are but varieties of one and the same type.

Geological formation and locality. In limestone of the age of the Hamilton group, at the Bake-oven, Illinois.

Chonetes setigera.

PLATE XXI.

Strophomena setigera : Hall, Geol. Report 4th District New York, p. 180. 1843.
Chonetes setigera : Hall, Tenth Report on the State Cabinet, p. 150.

Shell semielliptical; the cardinal line equalling the greatest width of the shell, and rarely extending beyond.

Ventral valve moderately convex, rarely a little gibbous in the middle; umbo scarcely rising above the hinge-line; the greatest elevation is above the middle of the shell, and gradually sloping to the front and baso-lateral margins; while it is a little more abruptly depressed in the upper lateral portions, and flattened on the cardinal angles. The cardinal margin is furnished with three slender tubular spines on each

side of the apex : these are bent a little outward as they leave the shell, and then rise almost vertically, or with a slight curve from the direction of the hinge-line.

The surface is marked by from 36 to 40 or 50 slender rounded or subangular striæ on the outer margin. In the upper and middle portions of the shell, the striæ are increased by bifurcation and intercalation. The radial striæ are crossed by fine concentric striæ.

This species occurs in the same black shale with *C. mucronata*, and may be distinguished from it by the more numerous and more frequently bifurcating striæ, which are likewise more angular. The direction of the cardinal spines, when present, is always a characteristic feature.

At one time I compared this species with *C. scitula;* but it is a very marked and distinct species, and not readily confounded with any other. In the concentric striæ it resembles *C. logani*, but the laminæ are closer, less undulating, and apparently do not affect the entire structure of the shell as in that species.

Numerous specimens of casts and impressions of the exterior shell in the Chemung group appear to be of this species : these will be illustrated on Plate 22.

Geological formation and localities. In the thinly laminated black Marcellus shale, at the base of the Hamilton group near Caledonia, N. Y.; and in the higher beds of the same group, as well as in the Genesee slate, on the outlet of Crooked lake; but it has not proved an abundant species in any of the localities examined.

Chonetes scitula.

PLATE XXI.

Chonetes scitula : Hall in Tenth Report on the State Cabinet, p. 147. 1857.
Compare *Chonetes lineata*, etc. this Vol. p. 121.

Shell transverse, semioval : hinge-line often not quite equalling the greatest width of the shell; cardinal angles rarely a little salient.

Ventral valve moderately gibbous in the middle, and regularly curving to the front and basal margins; the gibbous portions narrowing towards the hinge-line, and the umbo little elevated; abruptly depressed towards the cardinal angles, which are nearly flat and sometimes a little deflected at the extremities.

Dorsal valve with a concavity less than the convexity of the opposite valve; the cardinal angles flat.

AREA of the ventral valve narrow and distinctly wider in the middle, the exterior margin gently curving : foramen partially closed by a convex deltidium, and the aperture filled by the cardinal process of the opposite valve. Dorsal area linear, half as wide as that of the opposite valve.

SURFACE marked by fine subequal striæ, which are often alternated in size towards the margin. Of these, from 15 to 20 may be counted near the beak, while from bifurcation and intercalation there are from 50 to 60 on the margin, becoming obsolete towards the cardinal extremities. The striæ are sometimes sharp and angular, and sometimes rounded : fine concentric striæ are visible on well-preserved specimens.

The cardinal margin of the ventral valve is furnished with two or three spines on each side towards the extremities, and as many more towards the beak, so that the bases of five can be readily counted, and sometimes six; while there is a minute point on each side of the apex, which may be another spine; and this, if preserved, would give twelve or fourteen spines on the cardinal line.

The interior of the dorsal valve is strongly pustulose, with a somewhat broad depression along the centre, in the middle of which there is a slender mesial ridge. The muscular impressions are not strongly defined, but the limits of the vascular impressions are clearly seen. The cardinal process is short, and the inner margin of the hinge-line is thickened and rounded. The ventral valve shows a slender median ridge and two strong dental lamallæ. The muscular impressions are not strongly defined in specimens seen.

This species is closely related on the one side to *C. lineata* and *C. yandellana*, and on the other to *C. lepida*. With the latter it is frequently associated; differing from it, however, in its large size and the uniformly convex surface of the ventral valve, while that one has a depression along the middle. The striæ are more prominent than in *C. lineata*, and there is no flattening of the umbo and central portions of the ventral valve. It is nevertheless desirable to make more extensive comparisons of the interior structure than I have been able to do with my materials.

Geological formation and localities. In the Hamilton group, on the shores of Cayuga and Seneca lakes; at Ludlowville, on the shore of Canandaigua lake, at Moscow, at Hamburgh on the shore of Lake Erie; abundant near Onconta, and other localities.

Chonetes lepida.

PLATE XXI.

Chonetes lepida : Hall in Tenth Report on the State Cabinet, p. 148. 1857.

Shell small, scarcely transverse, semielliptical, subhemispherical : hinge-line about equalling the width of the shell below.

Ventral valve more or less gibbous, with a longitudinal depression along the centre in well-marked specimens; curving abruptly to the front and sides, with cardinal angles scarcely flattened.

Dorsal valve following the curvature of the opposite valve, with a lesser concavity.

Area of the ventral valve narrow, distinctly wider in the middle, and sloping with a gentle curve to the cardinal angles. The foramen is small, partially closed by a pseudo-deltidium, and filled by the cardinal process of the opposite valve. The dorsal area is scarcely equal to the thickness of the shell.

Surface marked by slender angular bifurcating striæ, of which there are ten or twelve near the umbo and twice as many on the margin, and in some specimens a larger number. Two of the striæ, on each side of the centre near the beak of the ventral valve, are larger and more prominent than the others : the space between them is depressed and occupied by two or three smaller striæ, which are given off from the larger ones on each side. The larger striæ are more prominent near the beak than on any other part of the valve, and give an almost bicarinate aspect to the umbo, with a distinct sinus which becomes obsolete near the base of the shell.

The hinge-line usually shows two or three spines on each side of the centre; but in some individuals, the bases of five spines can be distinctly seen on each side of the beak.

The interior of the dorsal valve shows a longitudinal depression, and the course of the striæ is well defined and strongly papillose.

The cardinal process has not been seen in its connexion with the dorsal valve. Some casts of the ventral valve show a gibbous centre,

which is constricted along its upper and lateral margins, and is marked by a longitudinal depression indicating the place of the median ridge and muscular impressions, while they are depressed towards the lateral and basal margins.

The original specimens designated as *C. lepida* are very small shells of almost hemispheric form, and one of the characteristics is the mesial depression of the ventral valve. The striæ are rather strong, angular, and, from dividing below, have the appearance of being fasciculate. More extensive collections have brought together a large number of individuals; and while the characteristic features are preserved in most of the specimens, there are others of the same size which seem like the young of *C. scitula;* but the well-marked specimens of this species have a convexity which precludes them from acquiring by growth the form and convexity of *C. scitula* in its characteristic phases.

Geological formation and localities. In the Marcellus shale near Darien in Erie county, and in the Hamilton group at Ludlowville and Ogden's ferry on the shore of Cayuga lake: it is often abundant at the outlet of Crooked lake, and at Hamburgh on the shore of Lake Erie, and occurs also in numerous other localities.

Chonetes coronata.

PLATE XXI.

Strophomena carinata (Scrive *coronata*) : Conrad, Jour. Acad. Na. Sci. Phila., Vol. viii, p. 257, 1842.
Not *Strophomena carinata*, Conrad, Annual Report on the Palæontology of New-York, p. 64. 1839.
Strophomena syrtalis : Conrad, Jour. Acad. Nat. Sci. Philadelphia, pa. 254, pl. 14, f. 1. 1842.
Compare *Chonetes littoni*, *C. maclurea*, *C. tuomeyi* and *C. martini*, Norwood and Pratten on the Genus Chonetes, pp. 25, 28 and 29, pl. 2, f. 4, 8, 9, and 10. 1855. Journal Academy of Nat. Sciences, Philadelphia, Vol. iii. 1854–5.

Shell transverse, somewhat broadly elliptical, the hinge-line being sometimes shorter than the width of the shell and the cardinal angles rounded : in others it is often equal to the greatest width of the shell, and its form is semioval, with the lateral margins nearly rectangular to the hinge-line, the width being about once and a half as great as the length. The cardinal angles are sometimes produced in short acute auriculate extensions.

Ventral valve varying from moderately convex in the younger shells, to very gibbous in the older ones; often a little flattened below the umbo, and this plane space gradually widening to the front. Sometimes there is a shallow undefined depression along the middle of the valve.

The outline of the valve presents a very regular convexity, while it is abruptly depressed towards the cardinal extremities, which are flattened and a little deflected to the ventral side.

The dorsal valve is variably concave, sometimes following nearly the contour of the ventral valve, but often very moderately concave or nearly flat in the middle and upper part, and more suddenly deflected towards the front and lateral margins, flattened at the cardinal extremities, and a little concave just below the hinge-line.

The surface is marked by numerous closely arranged slender subequal striæ, which are bifurcated or increased by intercalation, and are continued on the cardinal extremities to within a little distance of the hinge-line; beyond which, the surface is marked by lamellose concentric striæ. In well-preserved surfaces, the radiating striæ are crossed by undulating concentric striæ; but in the greater number of specimens, these are not preserved, and the radiating striæ have a fibrous appearance.*

The cardinal margin of the ventral valve is furnished with five, six or seven oblique tubular spines on each side of the apex, though usually only three or four are visible. The ventral area is usually narrow, sublinear, though often perceptibly triangular; the foramen is of moderate size, partially closed by a convex pseudo-deltidium, and the lower part occupied by the cardinal process. The dorsal area is linear, often more than half as wide as the ventral area, with a triangular space in the middle occupied by the cardinal process.

The interior of the ventral valve shows strong, very diverging dental lamellæ, a narrow median ridge with narrow oval occlusor muscular impressions, while the divaricator muscular impressions are wide and spreading; sometimes lobed or striate, and not very strongly limited on the distal margins. Outside of these, are the broader vascular areas; beyond which, and sometimes within their limits, the surface is strongly pustulose. The casts show the reverse of these features in a median depression and widely diverging dental impressions; the surface being

* Probably from a partial solution of the surface by iron pyrites.

deeply pitted outside of the vascular markings, and the margin strongly striate. In other specimens, the marks of striæ and the pitted or punctate surface extend over the larger part of the surface, the striæ sometimes continuing to the apex.

The interior of the dorsal valve shows deep dental sockets, with small occlusor muscular imprints and wide vascular areas which are but faintly marked; while outside of these the surface is strongly pustulose. There is a slender median ridge joining the base of the strong cardinal process: this process is deeply grooved in the middle, both on the inner and the exterior face, and the lateral process on each side is separated from the central one by a similar groove on the exterior or cardinal face. There is considerable difference in the length of this process in different individuals, and it is sometimes constricted below the lateral process; and in other specimens, the parts are equal. The surface is more or less marked by the exterior striæ, depending on the thickness of the shell; and not unfrequntly the concentric striæ are beautifully preserved upon the interior surface.

In the character of the surface striæ, there are many minute differences among a large number of individuals. Sometimes an entire surface will be seen to have the striæ all bifurcating, or with few intercalated ones; while others have all or nearly all the increase by intercalation.

The figures 10 *a* – *g* illustrate the principal varieties of form of this species, as it occurs in the calcareous shales of the Hamilton group in Central and Western New-York. Figures 9, 11 and 12 are from the typical specimens of *C. tuomeyi*, *C. martini* and *C. maclurea* of NORWOOD and PRATTEN, given for comparison with those of New-York.

The species described by Mr. CONRAD as *Strophomena syrtalis* (loc. cit.) seems to me not specifically distinct from *C. coronata*. It is known in the eastern and central parts of the State, occurring in some harder layers, usually much compressed or lying in great numbers together. The shell is generally partially exfoliated, or presents the interior surface, giving the character described by Mr. CONRAD of "minutely tuberculated ribs." The extreme flattening of the shells, packed together in great numbers, is due mainly to pressure; and in the same localities, a shell or cast found in softer shale outside of the mass, preserves a moderate convexity. Under these different aspects, it is not surprising that this

form should have been regarded as a distinct species. The casts show the impression of a strong cardinal process and widely diverging dental lamellæ, with deeply pitted surfaces towards the exterior margin. Some of these forms are illustrated on figures 13 *a* – *d* on Plate 21; and some of the larger individuals on Plate 22.

In these specimens, the cardinal extremities are often extended beyond the width of the shell below, as shown in figure 13 *b*, *c*; but the greater number preserve a form similar to that given by Mr. Conrad.

I have before me at this time, through the kindness of Dr. Norwood, the original specimens from which *C. martini*, *C. maclurea* and *C. tuomeyi* were described, as well as others corresponding to *C. littoni;* together with a considerable collection made by myself at the same locality from which they were obtained. After careful comparisons of all those from the western locality,* I am unable to recognize any specific difference among them; and they correspond as closely with *C. coronata* of New-York, presenting the same varieties of form, hinge-extension, convexity, and flattening or depression of the middle of the ventral valve, and the same variety in the bifurcation and intercalation of striæ. I feel compelled, therefore, to regard them all as varieties of the eastern type.

The *C. koninckı* of Norwood and Pratten, I am disposed to believe only a variety of the same form. A specimen from the original locality, near Jonesboro, Illinois, labelled by Dr. Norwood, presents no reliable characters for separation from some of the specimens from the Bake-oven.

The original of *C. tuomeyi*, figure 9 *a*, *b*, of Plate xxi, may be compared with the young of *C. coronata*, figures 11 *a*, *b*, of the same plate; and *C. maclurea*, figure 11, may be compared with *C. coronata*, figure 10 *h*, and others of the same; while *C. martini*, figure 12, may be compared with *C. coronata* in figure 10 *e*, or with figure 13 *e*. The *C. littoni* is intermediate in size between *C. tuomeyi* and *C. maclurea*, and may be compared with *C. coronata*, figure 10 *g*.

The general aspect of all the western specimens, which are in limestone, is that of having coarser and stronger striæ than the *C. coronata* of the soft shales of the Hamilton group in New-York. A careful measurement of the striæ on different parts of the shell, in a number of specimens from the central and western counties of this State, shows that they range from 9 to 15 striæ in the space of two-tenths of an inch; the majority being from twelve upwards in the centre, and from nine upwards near the front and basal margin of the shell. As a rule, the smaller specimens have the finer striæ.

Specimens of *C. tuomeyi* give from 9 to 12 striæ in the space of two-tenths of an inch: *C. maclurea*, which is larger than *C. tuomeyi*, gives 10 and 11 striæ in

* The Bake-oven, Illinois, on the Mississippi river.

the same space; and *C. martini*, 12 and 13 in the middle and 9 on the front. Specimens which were recognized by Messrs. Norwood and Pratten as *C. coronata*, from the same locality with the preceding species, give from 9 to 12 striæ in the space of two-tenths of an inch; in four specimens, the number 9 occurring four times, 10 four times, 11 twice and 12 once.

Chonetes syrtalis of Conrad gives from 8 to 15 striæ in the same space, one large individual (figured on Plate 22) giving 6 in front, 8 in the middle and 9 at the side. The smallest specimen measured, gave 14, 15 and 16, while the larger ones gave fewer striæ (8 – 12) in the same space. These measurements, if of any value at all, serve to confirm the view that all these varieties are but a single species.

Geological formation and localities. This species in its typical forms, occurs in the calcareous shales of the Hamilton group on the shores of Cayuga, Seneca and Canandaigua lakes; at Moscow and York, Livingston county; at Darien and Eighteen-mile creek, Erie county, and at other localities. In the form denominated *C. syrtalis*, it occurs in the harder shales at Cazenovia and Hamilton in Madison county, in Otsego county at several places, and at Fultonham and Summit in Schoharie county. It occurs in large numbers, associated with other known fossils of the Hamilton group, at the Bake-oven on the Mississippi river in Illinois.

Chonetes logani, var. aurora.

Chonetes logani : Norwood and Pratten, Jour. Acad. Natural Sciences, Philadelphia, Vol. iii. 1855. (Memoir, pa. 30, pl. ii, f. 12, *a*, *b*, *c*.)

The following description is given as above:

" Shell small, transverse; having its greatest breadth near the cardinal " border. Dorsal valve inflated; without a sinus; covered with about " thirty rugose ribs. Ears small and scarcely separated from the dorsal " vault; beak rather large and recurved. Ribs flattened and crossed " by fine lines: many of them are dichotomous. Area and ventral " valve unknown. Traces of tubes can be seen on the cardinal edge, " but the number cannot be ascertained. Dimensions: length, 6 milli- " metres; breadth, 9."*

* The fossil is cited as occurring in the middle portion of the Mountain limestone series; but I have been informed that this is an erroneous reference, and I have since received specimens, labelled by Dr. Norwood, from the Oolitic beds of Burlington, Iowa. The species is probably limited in its upward range to the lower calcareous beds of Burlington, and to the same horizon in the Mississippi valley. I have given a very different species under this name in the Iowa Geological Report, having accepted labelled specimens as authentic, without relying on the description and figure cited.

In the Tully limestone of New-York, we have a CHONETES which I am unable to distinguish by any positive specific characters from the *C. logani* of Burlington and other western localities..

The shell is moderately concavo-convex, semielleptical, the length and breadth being about as 6 or 7 to 9; the cardinal angles scarcely extended beyond the width of the shell. The ventral valve is moderately convex, sometimes gibbous a little above the middle, with the umbo prominent, regularly curving to the front and abruptly depressed towards the cardinal angles. The dorsal valve is regularly and moderately concave in the middle and lower part, and flattened towards the cardinal extremities.

The surface is marked by from twenty to forty low rounded costæ, many of which are dichotomous towards the margin. These costæ sometimes become obsolete towards the cardinal angles, but are often distinct nearly to the hinge-line. The entire surface is marked by elevated undulating concentric striæ which are sometimes equal to the space between them; but, when partially exfoliated (and sometimes in other conditions), are narrower than the intermediate spaces.

The margin of the cardinal area preserve four (or six?) somewhat strong oblique spines; the area is narrow. The interior of the dorsal valve is papillose, with a short cardinal process. Casts of the ventral valve are very convex in the upper part, with a narrow slit marking the place of the median septum, and, below this, preserving the marks of the bifurcating striæ, and sometimes the concentric striæ are visible near the margin.

In the shaly and calcareous rocks of Medina county, Ohio, there is a similar form of CHONETES, undistinguishable by any external characters from the specimens from the Tully limestone, except that the cardinal angles are sometimes a little more produced than is usual in that rock. In one specimen, equal in size to the largest from the Tully limestone, there are about forty costæ on the margin, and these are crossed by elevated striæ of precisely the same character. In numerous casts of the ventral valve, in the same association, there are characters similar to those noted in the Tully limestone specimens; the central or upper convex

portion being distinctly limited, while towards the margin the imprints of striæ are a little more definite than in the others. These slight differences between specimens occurring in limestone, and those in arenaceous beds, are almost universal in other examples of identical species occurring in the different sediments.

In the yellow sandstone of Licking county, Ohio, there are similar casts of CHONETES; and I have a piece of sandstone from near Bedford, Ohio, preserving several casts of the same species. These specimens from the several localities show, along the area line, the casts of five or six tubes on each side; the three inner ones are parallel to the sides of the foramen, while the others are less oblique. The three nearest the apex are not known to be produced into spines, but probably form minute pustules on the margin of the area.

In authentic specimens of *C. logani* from Burlington, there is great variation in the convexity of the ventral valve; the smaller and younger being moderately convex, while the older ones are ventricose. The number of costæ varies from twenty to forty. There are two spines (and rarely indications of a third) on each side of the beak. The area shows evidence of the oblique tubes observed in the casts.

The interior of the dorsal valve is papillose, with the striæ more or less strongly marked. The muscular and vascular impressions are often pretty well preserved. The cardinal process is short, and supported on each side by an elevated ridge, with or without an obsolete median ridge, giving the appearance presented by the cardinal process in some of the species of STREPTORHYNCHUS.

We have, therefore, a species of CHONETES, so far as we can judge by all visible features, ranging from the Tully limestone to the base of the Burlington limestone; or from the top of the Hamilton group to beds directly in conjunction with the base of the Carboniferous limestones, as known in Iowa and the Mississippi valley.

I have been indebted, in the first instance, to LEDYARD LINCKLAEN, Esq., of Cazenovia, for species of this fossil from DeRuyter; and subsequently it was found by Mr. WHITFIELD at Tully.

Geological formations and localities. In the Tully limestone, at Tully, Onondaga county, and at DeRuyter, Madison county, New-York; in Cuyahoga, Licking and Medina counties, Ohio. The typical forms of the species occur at Burlington, Iowa, and at Quincy, Illinois.

CHONETES OF THE CHEMUNG GROUP.

In certain localities of the Chemung group, within the State of New-York, there are numerous specimens of CHONETES; but they occur in the condition of casts of the interior, or of impressions of the exterior of the shell. The strata containing them present all the phases of argillaceous and arenaceous admixtures, sometimes a soft evenly laminated shale, and sometimes a coarse ferruginous sandstone. The fossils therefore present a great variety of aspect, and very different degrees of perfection and of prominence in the characteristic markings.

This condition, moreover, renders it the more difficult to make satisfactory comparisons with specimens retaining the shell, and occurring in other kinds of sediment. Notwithstanding these difficulties, I have, after much labor, satisfied myself that the greater part of all the specimens found in the Chemung group may be referred to three of the forms described from the Hamilton group: these are *C. scitula*, *C. lepida* and *C. setigera*. The two former, which I have sometimes been disposed to regard as perhaps identical species, maintain in the Chemung group the same differences that they show in the Hamilton group. There are a few obscure remains which do not appear referable to the preceding, having more numerous striæ than *C. scitula* and approaching in character *C. illinoisensis*.

In the higher strata of the Chemung group in Chautauqua county, and in similar beds at Meadville, Pa., a very marked and distinct species of CHONETES has been found. In its larger examples it equals in size and has the general form of *C. coronata* of the Hamilton group, but is readily distinguished by having a truncate apex and the surface studded with slender spines.

In extending our researches beyond the limits of the State of New-York, we find in the shales and sandstones of Eastern Ohio (which in part I regard as representing the Chemung group), one or two species not known in New-York: these, however, are associated with the *Cho-*

netes logani, which I have shown to occur in the Tully limestone of New-York; and although distinct species, are not in themselves evidence of a higher geological position.

From the fact that the three species first indicated have this great vertical range, we might infer that they would also show a wide geographical range; but this does not seem to hold true regarding them, in the line of exploration which has been followed.

The *Chonetes coronata* which is known in Eastern, Central and Western New-York in the Hamilton group, is also known in the same horizon in Illinois and Iowa; but it has not been recognized in the Chemung group of New-York, Pennsylvania or Ohio, nor elsewhere in that horizon.

If we regard the *Chonetes pusilla* as a variety of *C. laticosta* or *C. deflecta*, that species has a wide geographical range, since it occurs on the Mississippi river in Illinois; but it has not been found in New-York or elsewhere above the horizon of the Hamilton group. On the other hand, the *C. logani*, which begins its existence in the Tully limestone or the upper limit of the Hamilton group, ranges on the west to the base of the Carboniferous limestone, though unknown in the Chemung group of New-York.

I may, in the subsequent pages, call attention to other similar examples, in reference to geological and geographical distribution of species.

Chonetes scitula.

PLATE XXII.

[Reference page 130 of this volume.]

This species, in the shaly beds, preserves impressions of the exterior and casts of the interior, showing the characteristic surface markings, the spines of the area margin, etc.

In the coarser sandstones it is somewhat larger and coarser in its markings; and sometimes the striæ are nearly equal, presenting a character of surface observed in the Hamilton group.

The casts of the ventral valve show the filling of the minute tubes which correspond to those seen in the shell of the specimens from the Hamilton group.

This species occurs in the lower beds of the Chemung group near Trumansburgh, and at the Inclined Plane near Ithaca; at Painted-post and along the line of the Blossburgh railroad to Pennsylvania; at Grass-valley and Connewango in Cattaraugus county; at several localities in Chautaqua county, New-York, and at Meadville, Pennsylvania.

Chonetes lepida.

PLATE XXII.

[*Chonetes lepida*, p. 132 of this volume.]

This species occurs in the Chemung group, mostly in the condition of casts; and is distinguished from the casts of *C. scitula* by its smaller size and mesial depression.

In one or two localities it has been found with the shell preserved, and will probably be found in this condition in many places in the freshly quarried stone, beyond the influence of the weather.

The principal localities where it has been observed in this group are Great-valley and Connewango in Cattaraugus county, and Forestville in Chautauqua county. Rarely it has been observed in the specimens from Meadville, Pennsylvania.

Chonetes setigera.

PLATE XXII.

[*Chonetes setigera*, p. 129 of this volume.]

This species, which occurs in the Marcellus and Genesee slates, has not been found among the collections from the Chemung group in New-York; but it occurs associated with *C. scitula*, and other fossils of the Chemung group, at Meadville, Pennsylvania.

The specimens consist of casts of the ventral valve and impressions of the exterior of both valves. When the cardinal spines are present, the species is readily identified; but it may be distinguished from *C. scitula* by its greater proportional length, and by the rounded coarser striæ, and usually greater convexity of the ventral valve towards the apex.

Chonetes muricatus (n. s.).

PLATE XXII.

Shell of medium size, semielliptical, moderately or sometimes deeply concavo-convex : hinge-line usually less than the width of the shell, with the cardinal angles rounded.

Ventral valve moderately and regularly convex, sometimes gibbous; sides often nearly straight or a little inclined towards the hinge-line; the front broadly rounded, somewhat flattened towards the cardinal extremities which are indistinctly auriculated, frequently obliquely truncated on the umbo, with the apex slightly raised above the hinge-line. Area narrow, sometimes attaining a greater width, and extending to the cardinal extremities.

Dorsal valve moderately or deeply concave and following essentially the contour of the opposite valve, being a little shorter on the hinge-line, which is marked by a very narrow linear area; apex obliquely truncated, corresponding with the ventral valve.

The surface of the ventral valve is concentrically striated (probably only by the lines of growth) and with wrinkles along the cardinal margins, which become more or less obsolete on the body of the shell. The cardinal margin of the ventral valve is usually marked by a row of about four to six spines on each side of the apex, while the folds on the ears are similarly ornamented. On the body of the shell, the spines seem to have been more sparsely distributed; but towards the basal and basolateral margins they are closely disposed in concentric rows. The spines on the body of the shell are slender, and apparently of moderate length.

I have not been able to discover spines upon the dorsal valve, though concentric wrinkles mark the cardinal angles in the same manner as on the ventral valve, and the exterior is indented by fossets which cause pustules on the inner surface of the shell.

The specimens consist of casts or impressions of the interior and exterior; and the characters are drawn from these, and from wax impressions taken in the natural mould.

The cast of the ventral valve shows a sub-linear or low angular area, with a narrow foramen which has been covered by a pseudo-deltidium. The apex is bilobed, and there are cavities made by the teeth; and proceeding a little obliquely from these are gradually decreasing grooves diverging a little from the hinge-line, indicating an oblique ridge in the shell. From the outer extremity of these marks, a curving line parallel to the lateral margins of the shell indicates the limits of vascular impressions. The occlusor muscular imprints are two narrow elongate subtriangular or semioval scars, and directly below are some minute vascular markings which separate the wide flabelliform divaricator muscular impressions: these are faintly striate, and, when well preserved, are distinctly lobed, though usually not well defined on the exterior limits. The entire surface is striato-punctate.

The interior of a dorsal valve retaining the shell is papillose, becoming punctate on exfoliation, and showing pustules on the anterior margin. The impression of the exterior sometimes shows a truncate apex and the imprint of a cardinal process which is bilobed, and each division again divided (as shown in the figure).

A cast made from a mould of the interior of the dorsal valve (fig. 00) shows a slender median septum, which terminates in the cardinal process (the two principal lobes only being shown in that view). From near the base of the process on each side proceed the reniform vascular markings. The occlusor muscular imprints are minute elevations on each side of the median septum. The entire inner surface is striato-punctate.

The larger specimens are usually moderately convex; but some smaller ones are rather gibbous, possessing otherwise the characters of the larger individuals.

This species has the general form and proportions of *Chonetes fischeri;* but is distinguished by the broadly truncate apex, the wrinkles on the ventral and dorsal valves, and more especially by the presence of spines on the ears and upon the body of the shell: it has likewise a more distinct area on the ventral valve. The *C. fischeri* has the apex of the ventral valve often somewhat unequally depressed, and sometimes apparently a little irregularly produced and subtruncate;

while its surface markings, when entire, consist of fine closely arranged striæ, and in a partially exfoliated condition it is marked by two sets of excentric lines crossing each other, which give a very peculiar aspect; while the absence of spines upon the surface readily distinguishes it.

I have seen that species only from the beds below the Burlington limestone, at Burlington; and we do not know what modifications may take place in its characters in distant localities.

The *Chonetes muricata*, in its truncate apex and spiniferous surface, has the external aspect of STROPHALOSIA; but a careful examination shows all the distinctive features of CHONETES. A single specimen, partially preserving the shell on the hinge-line, shows an area on the ventral valve of nearly a line in width in the centre, the dorsal area being about one-third as wide.

Geological formation and localities. In the arenaceous and semicalcareous beds of the Chemung group, at Ellington in Chautauqua county, New-York; and at Meadville, Pennsylvania.

In addition to the species which are clearly recognised in the Chemung group, there are casts of the interior and impressions of the exterior of one or two others which cannot be satisfactorily referred to any known forms, and which are not in a condition to be described as distinct species.

In the eastern part of Ohio there is a species of CHONETES occurring in beds from sixty to one hundred feet below the Carboniferous conglomerate, and in a position somewhat higher than the beds from which the principal part of the fossils in New-York are obtained, which bears a close resemblance if not identity with the *C. illinoisensis*. It occurs in association with *C. logani*, and is distinguished by its larger and more gibbous form and finely striated surface, having from 80 to 120 fine subequal striæ upon the surface of the ventral valve. When exfoliated, the surface is finely and regularly punctate between the striæ. The cardinal margin bears three or four slender diverging spines on each side of the beak (not "five or six oblique spines on each side of the beak,") as in *C. illinoisensis*.

REMARKS ON THE GENERA PRODUCTUS AND STROPHALOSIA.

Among the genera of the Family Productidæ, there are recognized at the present time the following: Chonetes, Productus, Strophalosia and Aulosteges; the two latter being considered by Mr. Davidson as subgenera of Productus.

The Genus Chonetes has already been noticed in the preceding pages; and from its marked characters, there is usually little danger of confounding it with any other of the Productidæ. The Genus Productus, in its typical and varied forms, is characteristic of the Carboniferous period: a few species are known in the Permian, while other similar forms in the Devonian, which were formerly considered as Productus, have lately been referred to the genus or subgenus Strophalosia of Prof. King.

Productus, which is the oldest established genus, includes species described as semicircular or semioval concavo-convex shells, with spiniferous exterior surface, straight hinge-line, without an area on either valve, and without teeth or sockets. The interior characters, though with a general resemblance to Strophodonta, have in addition certain other points by which they are distinguished. Notwithstanding that the species of Productus have usually the shell more or less closely studded with spines, and generally a row of spines just below the hinge-margin of the ventral valve, there are some species referred to this genus which are nearly destitute of spines, and others upon which no spines have been detected except on the ears or near the cardinal margin. Species having this exterior character are usually more extremely gibbous or ventricose in the ventral valve than any species of Leptæna, Strophodonta or Chonetes, and the dorsal valve is more deeply concave.

Strophalosia is described as differing externally from Productus in sometimes having a truncate apex, and by the presence of an area of greater or less extent on each valve, with a foramen which is more or less closed by a deltidium. In the interior, it is said to be characterized by teeth in the ventral valve and teeth-sockets in the opposite valve;

while the disposition of the reniform vascular impressions of the dorsal valve is a distinctive feature.

In reference to the Genus PRODUCTUS, Mr. DAVIDSON remarks as follows :

" All well authenticated species of PRODUCTUS, hitherto examined, have shown " themselves to be edentulous; but whether this character was general and " without exception, may remain a question for further consideration : anyhow, " the dorsal valve must have turned on its hinge-line with as much precision as " in CHONETES, which possessed regularly articulating teeth. It has been often " asserted and believed that PRODUCTUS might be distinguished from its subgenera " by the total absence of an area; and although this is the prevalent character " of the genus, still in certain species, such as *P. sinuatus*, a perfectly developed " area is generally present in the ventral valve. There exists also an occasional " tendency to the formation of hinge-area in several species; as may be seen, for " example, in the remarkable example of *P. semireticulatus*, of which a repre- " sentation is given in Plate XLIII, fig. 5."*

These observations of Mr. DAVIDSON are of later date than his " Introduction to the Natural History of the Brachiopoda."

One of the important features of distinction between PRODUCTUS and STROPHALOSIA has been stated to be the different disposition of the reniform vascular impressions in the dorsal valve. The accompanying figures represent this character in two species of the latter genus, as given by Mr. DAVIDSON in his Introduction.

3

FIG. 3. STROPHALOSIA GOLDFUSSII.

4

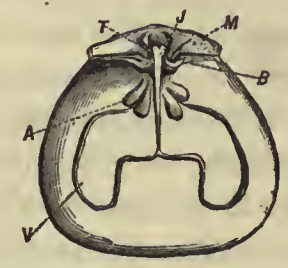

FIG. 4. STROPHALOSIA MORRISIANA.

In examining the species occurring in the higher formations of the New York rocks, which I had supposed might be referred to the Genus STROPHA-

* Monograph of British Carboniferous Brachiopoda, p. 136. 1861.

LOSIA, I find evidence of a narrow area with small teeth and sockets in the greater number of the species; although these features do not usually appear, except upon the most critical examination. The disposition of the reniform vascular impression, however, does not correspond with that of STROPHALOSIA; but in all the species where this feature has been observed, it is similar to that shown in figures 5 and 6.

5

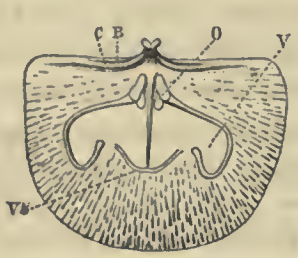

FIG. 5. PRODUCTELLA ONUSTA.
B C. Tooth-socket and socket plate.
J. Cardinal process. *O.* Anterior and posterior occlusors. *V.* The reniform vascular impressions.
*V**. This letter refers to the faint diverging impression proceeding from the extremity of the mesial septum of *P. onusta*. A similar marking has been observed in another species, but no connexion with the reniform vascular impressions has been observed.

6

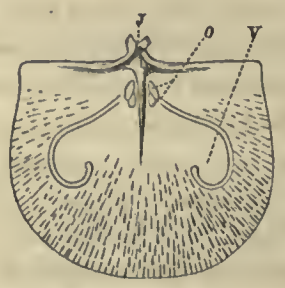

FIG. 6. PRODUCTELLA STRIATULA.
(Enlarged to two diameters).

Neither of these species are known to have the apex of the ventral valve truncated. In another species, with extremely gibbous and arcuate ventral valve and deeply concave dorsal valve, the disposition of the reniform impression is precisely like those illustrated; and in none of the species under investigation have we seen the least evidence of reniform impressions like those of figures 3 and 4, which are illustrations of Permian species of STROPHALOSIA.

It is clear, therefore, that this character could not be relied on for distinguishing the genus, if we were to include in it our Devonian species; for in the three species referred to, the imprint has the same direction and termination as shown in AULOSTEGES, except perhaps that the muscular scars may be a little nearer the hinge-line; and in this respect it is not very dissimilar to some species of PRODUCTUS, as shown in *P. costatus* (figure 7).*

* *Productus longispinus* and *P. pustulosus* have a similar form of the reniform impression. See DAVIDSON'S *Monograph of British Carboniferous Brachiopoda.*

I have moreover ascertained that the American forms of *P. costatus* have often a well defined area on the ventral valve, and a narrow area on the dorsal valve, extending nearly the entire length of the hinge-line; and in some specimens, this is as distinct as the area of STROPHODONTA or of CHONETES. There is of course a foramen, which is open in the examples observed; though in Mr. DAVIDSON'S figure of *P. semireticulatus*, cited above, the foramen is closed by a deltidium. The specimens of ventral valves of PRODUCTUS, which I have been able to examine, have no true teeth or extensions from the margins of the foramen; but sometimes a callosity extends obliquely backward and unites with the interior of the shell, being in fact as much a representation of dental lamellæ as we have in some species of STROPHODONTA.* The accompanying figure 8 illustrates the hinge-area of *P. costatus*; and figure 7 is of the interior of a dorsal valve, showing the muscular and vascular impressions.

7

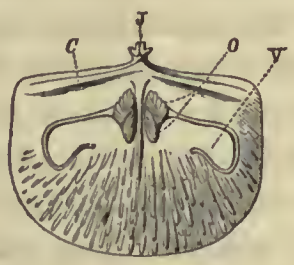

FIG. 7. PRODUCTUS COSTATUS.

Interior of the dorsal valve to show the reniform vascular impressions, cardinal process and the oblique callosity *C*.

8

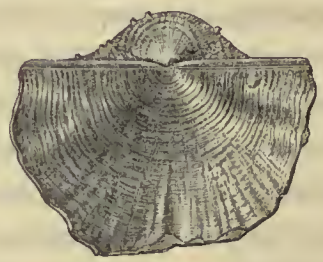

FIG. 8. PRODUCTUS COSTATUS.

Dorsal view of a specimen showing the hinge-area.

Thus we see that the species referred to PRODUCTUS may have all the characters of STROPHALOSIA except the hinge-teeth and sockets, and the disposition of the reniform impressions; while the New-York species, possessing teeth and sockets, have not the disposition of the reniform vascular impressions which are given by European authors as characteristic of STROPHALOSIA.

In glancing at the species of Productidæ illustrated on Plates 23, 24,

* See *Strophodonta demissa, S. reversa, S. nacrea* and others.

25 and 26 of this volume, one cannot fail to be impressed with the prevailing greater width on the hinge-line, and consequent modification of form in the American Devonian species, as compared with the STROPHALOSIA of the Permian system in Europe. But while the greater part, and perhaps all of these, have a narrow cardinal area and small hinge-teeth and sockets, I conceive that their exterior character and expression are much more like true PRODUCTUS than are the Permian species of STROPHALOSIA; and one of the most marked features consists in the conspicuous ears with rows of spines, as in Carboniferous Producti; while their anterior extension and highly arcuate forms assimilate them much more with PRODUCTUS than with STROPHALOSIA.

In the Upper Helderberg group, the Productidæ of this character make their first appearance in the American geological series, and continue with increasing numbers through the successive formations to the Carboniferous limestone. There are a few individuals of two species in the Corniferous limestone, and more in numbers of individuals and of other species in the Hamilton group; but it is difficult to find specimens in a condition favorable for satisfactory investigation. A few specimens have been obtained entirely separated from the rock; but nearly all are imbedded, with the ventral valve adhering to the matrix so that the hinge and interior structure can rarely be seen; while the dorsal valves almost uniformly adhere by their exterior surface, leaving only their interior for examination.

In the Chemung group, the specimens occur mostly as casts of the interior and impressions of the exterior, and these are frequently much distorted. In some of the softer compact shales of this group, we find the shell partially preserved, but still in such condition that the entire characters cannot be discovered; and it is only in some fresh exposures of the semicalcareous bands that we are able rarely to obtain specimens of more natural appearance and better preserved surface.

Under circumstances of so much difficulty, it is with much hesitation

that I approach the final disposition of the species of this character in our formations.*

It would appear that the Genus STROPHALOSIA has been founded upon characters derived entirely from Permian species, in which the interior structure has been well preserved. Of the few European Devonian species of this genus which are cited, I have seen no illustrations of the interior; and these have probably been referred to the genus from the generally similar form, the presence of a narrow area, and minute teeth and sockets, which are characters found in identical or similar forms in the American strata. It is probable, therefore, that had the interior of these species been observed, they would not have been placed among the Permian STROPHALOSIÆ, but rather among the PRODUCTI, to which they seem more nearly allied.†

It appears to me that we have in the Devonian period the incipient manifestation of the productidian type, which became modified in the later Carboniferous period, where, with conditions favorable to its excessive development, it has assumed extravagant forms and proportions, but here and there indicating the characters of its prototype in the presence of an area and foramen, among species of a genus which is characterized by the absence of these features. In the still later Permian period, with changed conditions, we have an approximate return to the earliest forms of the species, or to the prototype; and in reality the foundation of the genus lies in the Devonian forms which have been referred to STROPHALOSIA.

It would appear that the presence, rather than the absence of characters, should be the foundation of generic description and determination;

* Those who have the best right to criticise the work, from having themselves labored in a similar field, will appreciate the difficulties to be encountered; and they will only need to be assured of my earnest intention to dispose of the species without prejudice or partiality to previously expressed opinions. With larger collections before me than I had when originally describing the species under the preceding genera, I have seen cause to modify in some instances the views formerly maintained, and I believe I have shown no leniency towards species proposed by myself on insufficient materials; but I am quite unable, at the present time, to reduce the species of this type from these formations, to the limits indicated by European authors who have examined American collections.

† Prof. DE KONINCK, in his "Recherches des Animaux fossiles," has not recognized the Genus STROPHALOSIA; and the Devonian forms similar to those of our rocks are by him placed under PRODUCTUS.

and in that view PRODUCTUS possesses fewer characters, and in the absence of hinge-area, teeth and sockets, is less complete than the forms possessing these appendages. Nevertheless the great development of forms and number of species constituting the Genus PRODUCTUS during the Carboniferous period, has acquired for it the importance and distinction which it must retain; and any subdivisions proposed must have reference to the characters of this genus as established.

On a critical examination of the genera of the Family Productidæ, we shall find that CHONETES is distinguished by well-marked and important characters: having an area on each valve and a row of spines upon the margin of the area of the ventral valve, which is one of the distinguishing external features, though it has been ascertained that spines sometimes occur upon the body of the shell.

The separation of the genera or subgenera STROPHALOSIA and AULOSTEGES from PRODUCTUS is based upon less important differences. The former has an area on each valve, a foramen in the ventral valve covered by a deltidium, with teeth and sockets, while the reniform vascular imprints have a different direction and termination. The latter has a wide area on the ventral valve, a foramen closed by a pseudo-deltidium, with no teeth and teeth-sockets, and with the reniform vascular impressions extended far towards the anterior margin of the valve, and sometimes abruptly recurved.* The typical species of AULOSTEGES is very similar to STROPHALOSIA in external form. Both are from the Permian system, and the differences between them consist in the presence or absence of teeth and sockets, and the different direction of the reniform impressions.

While the typical and fully developed forms of STROPHALOSIA in the Permian System have a large area on the ventral valve, with a narrow area on the dorsal valve; all the New-York species have a very narrow area on each valve (often so narrow as to be no greater than the thickness of the shell), with the other general differences pointed out. These features alone might not be sufficient to indicate a distinct group; and a

* The disposition of the reniform impressions is not essentially different from that of some species of PRODUCTUS; and the presence of an area and covered foramen, and the absence of teeth and teeth-sockets are the distinguishing features.

little extension of the characters of PRODUCTUS or of STROPHALOSIA might include them; but while STROPHALOSIA and AULOSTEGES remain distinguished by such small differences, these forms also, I conceive, should be separated from the former, both on account of the external differences and from the direction of the reniform vascular impression, which has been regarded as an important feature in the Productidæ. These differences I consider as scarcely less important than those upon which the other subgenera have been separated; and from their external form and internal structure so nearly resembling PRODUCTUS, I would propose for the Devonian species having narrow hinge-areas and small teeth and sockets, with reniform vascular impressions of the form of those illustrated, the name PRODUCTELLA.

Subgenus Productella (n. s.g.)

SHELLS having the general form of PRODUCTUS, but uniformly with a narrow area on each valve, a foramen or callosity on the ventral area,* small teeth, and more or less distinct teeth-sockets.

The reniform vascular impression, rising from between the anterior and posterior occlusor muscular impressions, curves gently outwards, and following a curvature somewhat parallel with the margin of the shell to below the middle of its length, is abruptly recurved, and the extremity turned a little backwards teminates about half way between the margin and the anterior extremity of the mesial septum.

The cardinal process, seen from the inner side, is bilobed, and from the exterior side each of these divisions is usually bilobed.

These shells differ from STROPHALOSIA in the extremely narrow linear cardinal area, greater extension of the hinge-line, more extreme arcuation or ventricosity of the ventral valve in many or most of the species, and especially in the direction and termination of the reniform vascular impressions, which resemble those of AULOSTEGES and of some species of PRODUCTUS. It differs from PRODUCTUS in the constant presence of an area, hinge-teeth and sockets.

* In the specimens affording the most satisfactory evidence of area, etc., the foramen is open; but in some specimens the impression only remains, and there is the appearance of a narrow indentation below the beak, so that it is impossible to determine whether the foramen has been open, or closed by a deltidium.

PRODUCTELLÆ OF THE CORNIFEROUS LIMESTONE AND HAMILTON GROUP.

Productella subaculeata.

PLATE XXIII.

Productus subaculeatus : Murchison, 1840, Bull. de la Soc. Geol. de France, Vol. xl, pa. 255, pl. 2, f. 9 *a,b,c*.
Leptæna fragaria : J. de C. Sowerby, 1840, Transac. of the Geol. Society of London, 2d series, Vol. v, pa. 704, pl. 56, f. 5 and 6.
—— *oblonga?* : Idem, Ibid, pl. 53, f. 29; not Pander.
Producta ——— : Phillips, 1841, Pal. Foss. of Cornwall, pa. 59, pl. 25, f. 100.
Productus spinulosus (partim) : De Koninck, 1843, Desc. des Anim. foss. du terr. carb. de Belgium, p. 183 (fig. exclusis); not Sowerby.
—— *subaculeatus* (partim) : De Verneuil, 1843, Russia and the Ural Mountains, Vol. ii, pa. 282, pl. 16, f. 9, *a, b*, c.
——— ——— (partim) : De Keyserling, 1846, Reise in das Petschora-land, pa. 203, pl. 199 (fig. ex.).
Strophalosia subaculeata : King, 1846, Ann. and Mag. of Nat. History, Vol. xviii, p. 28.
Productus subaculeatus : De Koninck, 1846, Mem. de la Soc. royale des Sci. de Liege, Vol. iv, pa. 249, pl. 16, f. 4 *a–d*.
" " De Koninck, Recherces sur les Anim. fossiles, 1847, pa. 142, pl. 16, f. 4 *a, b, c, d*.

Ventral valve gibbous; length and breadth about as seven to eight: hinge-extremities angulated, and the margins being contracted a little below form small ears, while below this contraction the sides are regularly curved and the front is broadly rounded. The umbo is considerably elevated above the hinge-line, and the apex incurved.

Surface marked by closely arranged concentric striæ, and studded with slender rounded spines. On the upper part of the shell, and on the ears, these spines are round at the base, and rise directly from the surface. On the middle and lower part of the valve, there is a slight elevation of the surface a little above the base of the spine, but not a defined ridge. The number of spines on the individual figured has been sixty or more.

The following is the description of this species, given by De Koninck:

" Shell small, semiglobose, rounded. Dorsal valve not sinuate, very " gibbous, rather regularly arched. The surface is ornamented with a " great number of very faint striæ of growth, and scattered over with " tubes of which there usually remains only the circular or slightly elon-

" gated bases. The distribution of these tubes has no regularity : they " are cylindrical, rather short, and appear to have followed a direction " parallel to the curvature of the valve : they are more closely arranged " towards the little ears than upon other parts of the surface, and, upon " each side of the beak, form a range of four or five tubes directed back- " wards, extending a little distance beyond the cardinal line. The ears " are very small and fragile, and are terminated exteriorly in an obtuse " angle. The cardinal line is shorter than the transverse diameter. On " careful examination, we observe an extremely narrow area, divided in " the middle by a triangular opening which is obliterated and hidden by " the beak when the shell is placed upon its dorsal valve. Nevertheless " the beak is very short and little prominent, although gibbous at a " little distance from its extremity, and neatly separated from the " ears by a sudden curve. The ventral valve is entirely embraced " by the dorsal valve, in which it is deeply inserted, and which it fol- " lows in all its contour : it is garnished with some concentric wrinkles, " somewhat strongly defined upon the ears and upon the sides. Little " rounded fossets are irregularly distributed, and correspond to the ori- " gin of the tubes of the other valve."

" Dimensions. Average length, 16 millimetres. Proportions of length, breadth, height and thickness=100 : 113 : 65 : 20. The total number of tubes varies from 25 to 50."

Prof. DeKoninck remarks that this species is known in America by the name of *Strophomena lachrymosa*. The *Strophomena lachrymosa* of Conrad was described from the Chemung-narrows in New-York, and is a larger shell, with different characters from any one known to me in the Corniferous limestone of New-York or of the West, and does not at all resemble the figures of *P. subaculeatus* given by this author.

Geological formations and localities. This species has been cited by M. DeVerneuil as occurring at Charleston landing and Lewis creek in Indiana, and as traversing the Hamilton, Portage and Chemung groups. The specimen figured on Plate xxiii is from the Corniferous limestone at Jeffersonville, Indiana; and I presume is identical with specimens from Charleston landing.

I am unable to identify it with any species in the Hamilton and Chemung groups of New-York, though resembling some of those which I have placed under *P. shumardiana*. A larger collection of specimens may possibly show a passage from the one to the other.

Productella navicella.

Productus navicella : Hall in Tenth Report on the State Cabinet, p. 172. 1857.

Shell small, subelliptical; length greater than width : hinge-line a little less than the greatest width of the shell.

Ventral valve extremely gibbous in the middle, arcuate : beak very much incurved and projecting a little below the hinge-line. The umbo is elevated above the hinge-line about equal to one-third the length of the shell : sides sometimes nearly parallel for one-half their length below the hinge-line, sometimes gradually curving outwards. Dorsal valve extremely concave.

Surface marked by fine undulating concentric striæ, which are sometimes interrupted by irregular lamellæ. On the umbo and the cardinal extremities there are numerous minute cylindrical spines which rise almost directly from the surface, or with a scarcely perceptible elevation of the surface just above them. Below the umbo, the ridges above the spine-bases become more elongate and conspicuous, while on the middle and sides of the valve, and towards its lower margin, these become elongate costæ; and from them rise rounded spines, sometimes interrupting the continuity of the costæ, which at other times continue below the spine with some abatement of their strength. There are rarely spines rising from between the costæ, and sometimes the latter continue for some distance without spines.

The specimens referred to this species are distinguished by the narrow elongate form and extreme arcuation. No area, teeth or teeth-sockets have been observed, as the specimens are not in a condition to admit an examination of these parts.

The typical specimen is from the Hamilton group, and I have referred to the same species several specimens of similar form and proportions from the Corniferous limestone, which are more distinctly marked by continuous radiating costæ, some of which are bifurcated on the sides. All the individuals now referred to this species are small shells; and though we might suppose the conditions in the Corniferous limestone to have been favorable to their development, yet no specimens have been found larger than those figured on Plate xxiii.

One or two specimens of larger dimensions in the Hamilton group have a similar surface-marking, but a different form.

Geological formations and localities. In the Corniferous limestone in Schoharie county, and in the Hamilton group at Moscow and Pavilion, New-York.

Productella shumardiana.

PLATE XXIII.

Productus shumardianus : HALL, Geol. Report of Iowa, Vol. i, Part ii, pa. 499, pl. iii, f. 9, and pl. vii, f. 1.
Productus spinulicostus [in part] : HALL, Tenth Report on the State Cabinet, p. 173. 1857.
Productus concentricus : HALL, Tenth Report on the State Cabinet, p. 180.* Geological Report of Iowa, Vol. i, part ii, p. 517.
Productus pyxidatus [partim vel totum] : HALL, Geological Report of Iowa, Vol. i, part ii, p. 498.

SHELL concavo-convex, subhemispherical, wider than long: hinge-line nearly or quite equalling and sometimes greater than the width of the shell below.

VENTRAL valve very convex, gibbous in the middle and on the umbo, which is abruptly narrowed towards the beak, and the apex incurved over the hinge-line; the sides abruptly depressed towards the cardinal extremities, which are flattened and more or less auriculate. In one specimen observed, the apex is minutely truncate, and there is a barely perceptible line at the junction of the two valves, which indicates an area.

DORSAL valve concave, often corresponding essentially with the ventral valve; but sometimes nearly flat in the upper and central portions, and abruptly deflected towards the margin.

THE surface of the ventral valve is marked by intermittent radiating ridges, gradually rising from the surface and terminating below in elongate spines; while upon the upper part of the shell, about the umbo, there are scarcely perceptible elevations of the surface above the bases of the spines. There are sometimes one, two, or more spines upon the ears, but this does not appear to be a constant character: the entire surface is marked by close concentric undulating striæ.

* The Geological Report of Progress referred to in this and one or two other instances was communicated to the Governor as the law required, but it was not published, and the matter was incorporated in the volumes cited.

The dorsal valve is marked by few or many interrupted radiating ridges, but no spines have been observed attached to them.

The specimens are usually from half an inch to six-tenths of an inch wide; one well-formed specimen measures $\frac{9}{16}$ inch in length and $\frac{10}{16}$ inch in width.

The interior of the dorsal valve is often pretty regularly convex, and sometimes nearly flat in the upper part and abruptly deflected towards the front. The surface is marked by interrupted ridges and fine concentric striæ, with a bilobed or bifurcate cardinal process and faint indications of teeth-sockets.* The muscular impressions have not been distinctly observed; but the reniform vascular impressions in the Iowa specimens are similar to others of the genus. The interior of the ventral valve is unknown.

After a careful comparison of specimens from the Corniferous limestone and Hamilton group, with those from Burlington in Iowa and the town of Louisiana in Missouri, I am unable to find any differences which I believe to be of specific importance; and am therefore compelled to regard those of New-York as identical with those of the West. A specimen from the Corniferous limestone of Ohio is scarcely distinguishable by any character of form, or even in the color of the rock, from specimens of the Oolite limestone at Burlington in Iowa; and a well-formed specimen (figure 35, Plate 23) from the limestone of the Marcellus shale is distinguished from the Iowa specimens only by its dark color. In each, the surface striæ and the ridges at the base of the spines, as well as the form and measurements, correspond. It may be observed, however, that the prevailing form of the specimens from Burlington is somewhat broader than those from the Corniferous limestone, and that in the latter the ears as well as the spiniferous ridges are often more prominent.

In comparing a considerable number of specimens of *Productus shumardianus* from Burlington, Iowa, I find the form of the shell pretty constant; but there are sometimes more or fewer spines on the umbo, while in some specimens this part of the shell has scarcely any spines. There is a similar irregularity in the distribution of spines upon the body of the shell, and not unfrequently we find it almost destitute of these appendages, and scarcely separable from the forms I have described as *Productus pyxidatus*. The same differences are observable upon the dorsal valves of which we usually have the interior surface exposed; sometimes few, and sometimes numerous nodes, indicating the fossets of the exterior.

* In the greater number of individuals examined, it is impossible to determine that teeth-sockets do exist; the appearance, even under a lens, indicating their absence.

Specimens of this species, both from Iowa and New-York, have in some instances shown a very minute truncation at the apex; and in one or two individuals there is a barely perceptible indication of an area, which extends on either side half-way from the apex to the extremities.

This species has usually been referred to *P. murchisonianus* of De Koninck (which is also represented as having a narrow area, and belonging properly to the Genus Strophalosia). In the comparison of numerous forms which have been described as distinct species, and which he refers to this one, Prof. De Koninck remarks as follows:

"The greater number of these species have been established only upon imper-
" fect specimens, and require a rigorous revision by their authors. The *P. mur-*
" *chisonianus* to which we must refer, according to M. De Verneuil, the *Stropho-*
" *mena pustulosa* of Mr. Hall, is easily distinguished from the preceding species*
" by its area,† by the less profound insertion of its ventral valve, by the less con-
" siderable number of its tubercles, and by its transverse wrinkles. It is not
" always so easy to separate it from the *P. subaculeatus*."

The species described by me as *Strophomena pustulosa* has been alluded to under the preceding species, and appears to me to be the dorsal valve of a smaller species of Productella, the *P. truncata*. I can scarcely suppose that such extreme variations occur in the same species, as are shown in these two forms; and if so, we must confess that we have very feeble means of discriminating species among this group of shells. In the eastern part of the State, where the *P. truncata* is abundant, I have not seen the larger forms, though they occur in the same association on the shore of Lake Erie; yet in that locality we have at least fifty of the smaller forms where we find one of the larger, and but rarely an individual which might be doubtfully regarded as in an intermediate stage of growth.

Geological formations and localities. It will be observed that this species ranges from the Corniferous limestone to the Oolitic limestone, at the base of the Burlington limestone in Iowa. It occurs at Williamsville in the Corniferous limestone, and in the same rock in Ohio and in Illinois. It is found in the limestone of the Marcellus shale on the shore of Lake Erie above Buffalo, and in the shales of the Hamilton group at the same place; at Pratt's falls in Onondaga county; at Moscow in Livingston county, and other places. It occurs in the same horizon at

* *Productus gerardi.*

† Among the illustrations of this species by Prof. De Koninck, pl. xvi, fig. 3 *f*, shows a narrow area and minute foramen; while figs. 3 *b* and 3 *e*, which are similar views of other specimens, do not show an area, and have every external appearance of being true Productus. The *Strophomena membranacea* of Vanuxem, supposed by that author to be identical with *Leptæna membranacea* of Phillips, is also cited by Prof. De Koninck as one of the synonymes under *Produetus murchisonianus*. The species referred to by Vanuxem is illustrated under *Productella hirsuta* of the Chemung group, and is certainly very distinct from either of those in the Hamilton group or Corniferous limestone.

Hamburgh (Illinois) and in the town of Louisiana (Missouri), and in the calcareous beds at the base of the Burlington limestone at Burlington (Iowa).

In the Tully limestone there is a very extreme form, which, after careful comparison, I can only regard as a variety of this species, having the front greatly produced. The beak is extremely incurved, and can only have been minutely if at all truncated.

Productella spinulicosta.

PLATE XXIII.

Productus spinulicosta : HALL, Tenth Report on the State Cabinet, p. 173. 1857.

SHELL broad, semielliptical or somewhat orbicular; hinge-line generally a little less than the greatest width of the shell.

VENTRAL valve varying in shells of different size, from moderately to extremely gibbous in the middle, with the beak strongly incurved.

DORSAL valve moderately concave in its upper part, and becoming more concave or arcuate towards the front.

SURFACE marked by fine strong concentric striæ, which are sometimes crowded and wrinkled on the body of the shell. There are several rows of interrupted ridges or spine-bases, which in entire specimens support slender spines. The ears are strongly wrinkled, and support a row of four or five spines just below the hinge-line.

The distinction between the species and the authentic specimens of *P. shumardiana* is not such as to entirely satisfy me of their specific difference. The specimens originally referred by me to this species are smaller than the prevailing size of *P. shumardiana* at Burlington, Iowa, and some of the younger individuals are somewhat broadly truncated at the apex. The spiniferous ridges are usually longer and more prominent than in the Burlington specimens.

Geological formation and localities. In the calcareous bands of the Marcellus shale and in the shales of the Hamilton group, on the shores of Lake Erie, Cayuga and Seneca lakes and other places.

Productella truncata.

PLATE XXIII.

Productus truncatus : HALL in Tenth Report on the State Cabinet, p. 171. 1857.
Strophomena pustulosa : HALL, Geol. Report 4th District New-York, p. 189, f. 4. 1843.
Not *Productus pustulosus* : PHILLIPS.

SHELL small, concavo-convex: hinge-line equalling or less than the greatest width of the shell.

VENTRAL valve gibbous in the middle, broadly truncate on the umbo, regularly curving to the front, abruptly depressed at the sides, and forming narrow flattened ears at the cardinal extremities. A narrow linear area, and a perceptible foramen or callosity under the beak.

DORSAL valve moderately concave, minutely truncate at the apex, with a thickening of the hinge-line in well-marked specimens.

SURFACE of ventral valve wrinkled at the hinge-line, marked by a greater or less number of spiniferous ridges, supporting slender spines of moderate length. There is usually a row of two or three spines on the ears just below the hinge-margin, and they are often closely arranged about the limits of the truncation on the umbo, and more sparsely on the middle and lower part of the valve. The dorsal valve is wrinkled along the hinge-line, and the surface covered by numerous elongate spiniferous pustules, bearing, when perfect, long slender spines. The entire surface of both valves is marked by fine closely arranged concentric striæ. Interior of the dorsal valve wrinkled and pustulose, with a conspicuous depression at the umbo, and a short bifurcating cardinal process.

This little shell is extremely abundant in the calcareous bands of the Marcellus shale, the individuals sometimes lying in absolute contact or close proximity through layers of considerable extent. They vary in size from the diameter of less than one line to a quarter of an inch, and rarely to three-eighths of an inch. Notwithstanding the great numbers of specimens, I have not yet been able to trace them to any larger size than those illustrated, though they may attain greater dimensions. In the larger specimens they very much resemble the young of *Productus* (*Productella*) *shumardianus;* but they are much more gibbous, the truncation is broader, and the area more conspicuous.

The species described by me as *Strophomena pustulosa* from the Marcellus shale, is apparently the dorsal valve of this species, some of the specimens being illustrated on Plate XXIII. Some of these valves are larger than any of the ventral valves which have been elsewhere seen; but since we know no other species in that association, I have referred them to the same.

On the authority of M. DE VERNEUIL, the *S. pustulosa* has been referred to the *Productus* (*Strophalosia*) *murchisonianus* of DE KONINCK, which is likewise regarded as identical with the species I have described as *Productus shumardianus.*

The illustrations on Plate XXIII, figures 18, 19 & 20 are enlarged three diameters, and those from 12–17 are enlarged two diameters. The interior of the dorsal valve showing the cardinal process, is enlarged six diameters.

Figure 23 represents the impression left in the stone by a dorsal valve, with the area and minute foramen of the ventral valve. This one is a little less broadly truncate, and presents other slight differences from the ordinary forms of this species.

Geological formation and localities. This species occurs principally in the calcareous beds of the Marcellus shale, and in the shale itself. It is found in large numbers near Schoharie, and also near Manlius in Onondaga county, at Avon in Livingston county, and on the shore of Lake Erie above Buffalo. It occurs also in the shale of the Hamilton group near Tully in Onondaga county.

Productella dumosa.

PLATE XXIII.

Productus dumosus : HALL, Fourteenth Report on the State Cabinet, p. 99. 1861.

Compare *Productus spinulicosta* : HALL in Tenth Report on the State Cabinet, p. 173. 1857.

Compare *Productus shumardianus* : Geol. Report of Iowa, Vol. I, part ii, pa. 499, pl. 3, f. 9, and pl. 7 f. 1; and this volume p. 150.

BODY of the shell subovate, and, including the ears, somewhat hemispheric; length and width about equal; the hinge-line usually a little less than the greatest width of the shell.

VENTRAL valve extremely gibbous or ventricose in the middle, contracted at the umbo, which is prominent, with the beak strongly incurved over the hinge-line. The middle and lower part of the shell is regularly arching, and almost vertically depressed at the sides of the umbo to the narrow flat ears. Dorsal valve more or less deeply concave, corresponding nearly with the opposite valve.

THE surface of the ventral valve is marked by numerous slender spines, the bases only of which are usually preserved. The spines on the umbo, and a row on the ears, rise almost vertically from the surface; while below this the surface is marked by short rounded ridges, each of which terminates in a slender spine. Towards the front of the shell the ridges are continuous, being only slightly interrupted by the growth of the spines. The bases of the spines are more or less distinctly arranged in concentric rows, and vary greatly in their number and proximity to each other. The entire surface is marked by closely

arranged undulating concentric striæ. The dorsal valve, in its upper part, is marked by rounded fossets, while on the middle and lower part the depressions become elongate grooves. No spines have been observed.

A careful examination of the hinge-line of the ventral valve has shown a narrow area, with foramen and small teeth. In one specimen, preserving the two valves, there is a barely perceptible separation of the margins for a short distance along the middle of the hinge-line; while in another similar specimen, there is no such separation perceptible.

This species is from half an inch to an inch in length and diameter. The variations in its different stages of growth, and the variable number of spines upon its surface, render it difficult, with the materials before me, to point out the characters which separate some of the smaller specimens, on the one hand from *P. navicella*, and the other from some forms of *P. shumardiana*.

Geological formation and localities. This fossil occurs in the Hamilton group, at Tinker's falls and Delphi falls in Onondaga county; at Bellona in Yates county; on the shore of Canandaigua lake; at Moscow in Livingston county; and near Hamilton in Madison county, New-York.

Productella exanthemata.

PLATE XXIII.

Productus exanthematus : HALL in Tenth Report on the State Cabinet, p. 174. 1857.

THE original of this species is a moderately concave dorsal valve, the interior of which is closely studded with pustuliform elevations, indicating fossets on the exterior of the shell. Near the umbo these elevations are nearly round, becoming oval below, and sometimes forming short oblique wrinkles. The cardinal process is distinctly bilobed; and there are obscure indications of teeth-sockets.

The characters are dissimilar to those of the interior of valves of well-marked specimens of *P. shumardiana*, though many of the dorsal valves of that species show numerous short ridges on the interior surface; but I have not been able to find a gradation to this character. Among the collections from the Corniferous limestone, there are several other dorsal valves with a similar cardinal process, and round pustuliform elevations in the upper part of the shell, while they

become elongated below, with numerous oblique wrinkles. It is equally difficult to unite these with typical forms of *P. shumardiana*, though ultimately all these varieties may be found to constitute only phases of a very variable species. Some examples of dorsal valves, similar to the typical forms of *P. exanthamata*, have been found in the Chemung group; but all these are moderately concave, and never approach the form of typical *P. shumardiana*.

Geological formation and localities. In the shales of the Hamilton group, on the shore of Seneca lake; and at Tinker's falls, Onondaga county.

Productella tullia (n. s.).

PLATE XXIII.

SHELL broadly ovate, subhemispheric; hinge-line equalling or a little less than the greatest width of the shell.

VENTRAL valve ventricose with the apex extremely incurved, and much produced in front.

DORSAL valve more or less gibbous, often moderately concave in the upper and middle portions, and abruptly deflected and produced in front.

SURFACE of ventral valve marked by scattered slender spines. Specimens of the dorsal valves are nearly all of the interior, strongly wrinkled on the hinge-line, with numerous pustuliform elevations, which become elongated on the front of the valve. Between these stronger elevations are numerous fine and sometimes coarser radiating striæ which become more distinctly visible as the shell is exfoliated from the inside, showing that they pertain to the exterior surface. The cardinal process is bifurcate, and of considerable length.

The interior of the dorsal valve is recognized by numerous pustuliform ridges and distinct intermediate striæ, the latter a character not observed in any other species.

The figures 41–44 illustrate the usual form and features of this species as it occurs in the Hamilton shales.

Geological formation and localities. In the Hamilton group, near Tully and Delphi falls in Onondaga county. A single dorsal valve of larger size and moderate convexity is from the Tully limestone.

Productella subalata.

PLATE XXIII.

Productus subalatus : Tenth Report on the State Cabinet, p. 174. 1847.
" " Geological Report of Iowa, part ii, pa. 500, pl. 3, f. 10.

Shell semielliptical or semicircular, usually much wider than high; hinge-extremities equalling or less than the width of the shell. Ventral valve ventricose in the middle, gibbous on the umbo and towards the beak; extended, flattened and auriculate at the hinge-extremities: beak incurved over the hinge-line. There is a distinct narrow area extending for more than half the length of the hinge-line.

The surface is marked by fine concentric striæ, with indications of radiating striæ within the substance of the shell. The cardinal margins and the ears are marked by strong wrinkles which are often visible on the body of the shell. The spines are variable in number, often crowded together on the ears and adjacent portions of the shell, and irregularly scattered upon the middle and anterior part of the valve.

This species is noticed in this place from its great similarity to the *P. rarispina* of the Chemung group of New-York. The specimen figured (Pl. xxiii, f. 49) is a ventral valve above the prevailing size, with a greater extension of the hinge-line than usual.

Geological formation and locality. In the calcareous shales of the Hamilton group at Rock island, Illinois.

Productus? ——— (sp.).

PLATE XXIII.

A single dorsal valve, of comparatively large size, occurs with *P. spinulicosta*, near Bellona in Yates county. When entire, it has had a length of about one inch and a quarter, with a width of an inch and a half. The interior of the shell is exposed, but the cardinal process is broken off, and there are no teeth-sockets visible. The surface is marked by slender pustuliform ridges, which become more elongate as they recede from the hinge-line, and on the middle and lower part of the shell are bifurcated, and show finer ridges between.

This specimen cannot be clearly identified with any described form; but in the absence of other material, I hesitate to indicate it as a distinct species.

Geological formation and locality. In the shales of the Hamilton group, near Bellona, Yates county.

PRODUCTELLÆ OF THE CHEMUNG GROUP.

Productella hirsuta.

PLATE XXIV.

Strophomena membranacea : Vanuxem, Rep. 3d Geol. Dist. New-York, p. 168, f. 4 and 5.
Not *Leptæna membranacea* : Phillips, Pal. Fossils, p. 60, f. 101.
Not *Productus membranaceus* : Hall in Tenth Report on the State Cabinet, p. 175. 1857.

Shell semielliptical, concavo-convex : hinge-line equalling or a little less than the width of the shell; length and breadth about as 8 to 10 or 12, or as 9 to 11, and, from natural or accidental causes, varying to length and breadth equal.

Ventral valve convex in the middle, gibbous on the umbo, gradually curving to the front and lower lateral margins, and abruptly depressed towards the cardino-lateral margins, which are nearly flat and broadly auriculate, with extremities usually rounded. Dorsal valve moderately concave, flattened towards the cardinal extremities, which are always rounded.

Surface marked by fine imbricating concentric striæ. On the ventral valve there is a row of somewhat strong, diverging, nearly straight spines on each side just below the hinge-margin; and the entire surface (except sometimes the umbo and more prominent portions of the valve) is covered by numerous slender spines, the bases of which form small elongate pustules on the surface. There is some evidence of an extremely narrow area on the ventral valve, and of teeth-sockets in the dorsal valve.

In a cast of the ventral valve, the occlusor muscular imprints are narrow and semioval, but no distinct impressions of the divaricator muscles have been observed. There is doubtful evidence of the presence of hinge-teeth. The interior of the dorsal valve is marked by numerous fine elongate papillæ, and towards the margin these are very closely arranged, giving a peculiar striated aspect to the surface (a feature more percepti-

ble in specimens from the shaly beds than in those from the arenaceous portions of the group). In the midst of these are the coarser pustules indicating the spine-bases of the exterior surface. The cardinal process is short and strong, bilobed at the extremity, with each division less deeply lobed. The process is supported at the base by an oblique ridge, which is often not visibly separated from the hinge-margin, but in rare examples has shown obscure evidence of teeth-sockets. There is a slender median septum, which is not always preserved, on the interior surface of the dorsal valve.

This species is subject to considerable variation in form, being often much extended on the hinge, and nearly once and a half as wide as long, while in other examples the length is nearly equal to the breadth : those with the length and breadth nearly equal, are the most gibbous in form. Not unfrequently the shell appears to have been unequally developed on the two sides of the apex. The species is distinguished from its associates by its wide moderately convex form, concentric striæ and very slender spines, the bases of which are usually but little extended on the surface. The interior is more finely papillose than the other species.

I believe this to be the species which Mr. Vanuxem regarded as identical with *Leptæna membranacea* of Phillips, and which has been recognized as *Productus* (*Strophalosia*) *murchisonianus* by De Koninck. I am quite unable, however, to find corresponding characters, and am therefore constrained to adhere to the specific designation applied by me in 1857.

Figures 1–9 illustrate the prevailing forms of this species. The dorsal valves all show the interior surface, while the ventral valves partially preserve the exterior, but in many of them the shell is more or less removed by maceration and solution. The spines on the surface are rarely preserved, but in some specimens the row of long spines near the hinge-margin is seen in part, as illustrated in two of the figures. Figure 9 is a ventral valve, which is more rotund and shorter on the hinge-line than usual.

Geological formation and localities. This species is of common occurrence in the green arenaceous shales of the Chemung group at Philipsburgh and Rockville in Allegany county; along the line of the Corning and Blossburgh railway; and at Covington, Pennsylvania.

Productella hirsuta, *var.* rectispina.

PLATE XXIV.

A group of figures at the lower part of this plate were originally separated, under the impression that they were a distinct species; but later examination has induced me to unite them with this as a variety, till more positive differences can be ascertained. They occur in a fine fissile and almost slaty sandstone in the Chemung group in the south part of Steuben county, and a few specimens from other localities have the same characters: these hold a somewhat higher position in the series than those from Philipsburgh. The condition of their preservation in a coarse matrix has given a somewhat different aspect to the surface markings, and the spines on the hinge-line, when preserved, are vertical; while in the specimens from Philipsburgh and the Blossburgh railroad, the spines are always directed obliquely outwards. The same feature of distortion or inequality on the two sides of the beak prevail in all the specimens from this locality in Steuben county, as well as in those of Allegany county and other places. The casts or impressions in this rock have a more coarsely pustulose or wrinkled surface; and in some imperfect specimens of the same type from Meadville (Pennsylvania), the valves have had a diameter of more than two inches, and the surface is strongly wrinkled on and near the cardinal margins.

A single individual in a semicalcareous matrix from Troup's creek near the Pennsylvania line, in the vicinity of the sandstone specimens, preserves the surface characters in greater perfection than any specimen elsewhere observed. An enlarged view of a portion of this shell is given in one of the figures.

Productella boydii.

PLATE XXIV.

Productus boydii : Hall in Tenth Report on the State Cabinet, p. 179. 1857.

Shell of medium size or larger, transverse, varying from semielliptical to broad-oval from the rounding of the cardinal extremities; cardinal line less than the width of the shell.

Ventral valve varying from moderately convex to gibbous in the middle and towards the umbo, with a more or less defined mesial depression extending from the umbo to the front of the shell, which is sinuate, somewhat gently curving to the front and baso-lateral margins, abruptly depressed on the cardino-lateral slopes, and extended into wide ears which are more or less distinctly rounded at the extremities.

Dorsal valve moderately concave, with a distinct longitudinal mesial elevation corresponding to the depression of the ventral valve, and giving the basal margin a sinuate outline. Cardinal extremities rounded, and the cardinal line much shorter than the width of the shell.

Surface concentrically striated, and marked by numerous elongate pustuliform spiniferous ridges supporting slender elongate spines, while there are one or two rows of stronger curving spines on the ears. The interior of the dorsal valve is marked in like manner by pustuliform nodes, indicating fossets on the exterior surface, which sometimes have their length transverse to the shell, or producing short transverse wrinkles. In some specimens, faint radiating striæ mark the surface of the shell.

The casts of the ventral valve show the marks of the occlusor muscles near the apex on each side of the mesial depression, which, on the interior of the shell, would be an elevated ridge. The divaricator muscular impressions are deeply striated, wide and spreading, extending nearly to the middle of the length of the shell. The interior of the dorsal valve shows a narrow mesial septum, but the cardinal process has not been determined. The whole interior surface is papillose or punctate.

This species is distinguished by the prominent and rather distant spiniferous tubercles, by the shallow median depression of the ventral valve, and also by the strong curving spines on the cardino-lateral margins. In an examination of twenty or thirty individuals of this species, I am unable to find any variations or gradations that would indicate an approach to any other species. The shell appears to have been very variable in form in its normal condition, and this variation has been increased by pressure during the consolidation of the matrix. The form of the valves does not vary greatly from those of *P. hirsutus*, but it is usually proportionally shorter on the hinge-line.

The specimens, though occurring in considerable numbers, have not afforded satisfactory means of determining the character of the hinge, or the presence or absence of an area.

Geological formation and locality. In the Chemung group at Philipsburgh in Allegany county, and near Elmira.

Productella rarispina.

PLATE XXIV.

Productus rarispinus : Hall in Tenth Report on the State Cabinet, p. 178. 1857.

Shell semielliptical; the proportions of length and breadth as 6 to 8, as 7 to 10, or sometimes equal; hinge-line equalling or a little greater than the width of the shell.

Ventral valve ventricose, somewhat flattened or slightly depressed in the middle, curving abruptly to the front, and a little more gradually to the baso-lateral margins, abruptly depressed on the cardino-lateral slopes and expanded into ears which are strongly deflected at the extremities.

Dorsal valve deeply concave in the middle, flattened or slightly concave on the cardinal angles.

Surface marked by fine concentric striæ, and sometimes, in partially exfoliated shells, there are appearances of radiating striæ. The ears are strongly wrinkled, and support several comparatively strong rounded spines, and others of similar character are scattered over the surface. These spines rise directly from the shell, with a pustule-like elevation on all sides, but not raised in elongate nodes as in most of the species. The dorsal valve also bears marks of a few similar spines.

A careful observation of the hinge-line of the ventral valve discloses an extremely narrow flat space, which may be regarded as an area with a narrow open aperture; but so obscure are these features, that, unless examined with great care, they may be readily overlooked.

The cast of the ventral valve shows elongate semioval imprints of the occlusor muscles on the umbo, and wide spreading strongly striate divaricator muscular impressions.

In the interior of the dorsal valve we find a slender mesial septum which terminates in a bilobate cardinal process, the shell being somewhat thickened at the sides, and probably having minute dental sockets; but these have not been distinguished. The entire interior surface of both valves is minutely papillose, and these points become more elongate on the middle of the shell, and finally towards the front are extended in extremely slender striæ, which are likewise impressed upon the cast.

The figures 19–23 of Plate XXIV illustrate the usual form and condition of this species; one specimen preserving two of the spines, and showing the bases of others on the surface of the valve.

This species occurs in the same beds with *P. hirsuta* and *P. boydii*, and is readily distinguished from either of these by its greater gibbosity and fewer spines; while the casts may be recognized by the extremely fine papillæ, and their extension in capillary striæ. In general characters, it resembles *P. subalata* of the Hamilton group at Rock island, Illinois; but it is much more convex, and the ears less extended than the usual form of the specimens from the western locality. The specimens before me are not in a condition for satisfactory comparisons of the two forms in all their parts; but I would suggest that such comparisons be instituted, with a view to determine the relations of the species.

Geological formation and localities. In the arenaceous shales of the Chemung group at Philipsburgh in Allegany county, and on the line of the Corning and Blossburgh railroad.

Productella lachrymosa.

PLATE XXV

Strophomena lachrymosa : Conrad, Jour. Acad. Nat. Sciences Philadelphia, Vol. viii, pa. 256, pl. 11, f. 9.

Shell ovoid or subhemispheric, semielliptical in outline; the proportions varying from nearly equal length and breadth, to width nearly once and a half as great as the length : hinge-line equalling or less than the width of the shell; extremities angulated or rounded.

Ventral valve varying from moderately gibbous to very ventricose; the umbo sometimes a little elevated above the hinge-line and often extremely elevated and incurved, often flattened in the middle, more or less regularly arching from beak to base, abruptly depressed at the sides of the umbo, and spreading into more or less expanded ears, which are usually deflected, and rarely extend beyond the width of the shell below : basal margin regularly arched, or sometimes nearly straight in the middle.

Dorsal valve moderately or more deeply concave, following in some degree the curvature of the opposite valve. In some specimens it is nearly flat in the upper and middle portions, and abruptly deflected at the margin.

Surface of ventral valve (where the shell is partially preserved) marked by fine concentric striæ, and, upon the ears, by strong concentric wrinkles, which become obsolete or are but faintly marked on the body of the shell. There is a row of four or five round spines rising from a little below the cardinal margin on each side of the beak; and surfaces of the casts are marked by numerous slightly elongate spiniferous tubercles, from which rise somewhat slender spines. These spiniferous tubercles are sometimes principally arranged in lines along partially continuous ridges. The dorsal valve is strongly wrinkled on the hinge-line, and sometimes these marks are continued across the valve in considerable strength; but the specimens examined do not show spine-bases. The casts or impressions of the exterior show pustules which indicate fossets on the exterior surface of the shell.

The interior of the valve is finely papillose and papillose-striate, so that some of the casts have a minutely interruptedly-striate surface. The cast of the ventral valve preserves irregular and somewhat elongate semioval imprints of the occlusor muscles, and the impressions of the divaricator muscles are deeply striated, wide spreading, reaching the inner margin of the wings, and extending for more than one-third the length of the valve. The cardinal process of the dorsal valve is bilobed in the middle, and each lobe is again divided, leaving a quadruple imprint on the stone.

This shell is subject to much variation in the convexity of the ventral valve, and also in the distribution of the spiniferous tubercles. The larger number of specimens are ventricose, a little flattened and rarely depressed along the middle.

Mr. Conrad has described the ventral valve of *S. lachrymosa* as "ventricose, "depressed towards the hinge-extremities; disc slightly flattened in the mid- "dle, marked with numerous elongated tubercles arranged in radii which "profoundly bifurcate; hinge-line not salient at the extremities, angulated, "sub-margin with prominent tubercles; umbo ventricose; summit above the "cardinal line. *Locality*: Chemung-narrows, New-York, Devonian shale."

The specimens in my collections from the Chemung-narrows are usually not extremely ventricose, and the spiniferous tubercles are more elongate than in most other species in the collection, sometimes becoming costæ towards the front of the shell. This feature is shown in some of the figures on Plate xxv, while other figures illustrate the prevailing forms of those which I have referred to this species from Cattaraugus county and farther west.

Notwithstanding the variable character of the species, it is for the most part readily recognized among the others of the group; and it certainly has no very close resemblance to any of the forms in the Corniferous limestone or Hamilton group.

The casts show faint indications of an area, and of teeth in the ventral valve; but teeth-sockets are not visible in the dorsal valves of any specimens I have thus far examined.

Geological formation and localities. In the Chemung group, near Factoryville and Chemung-narrows, Chemung county; at Painted-post, and near Bath in Steuben county; near Conewango and Randolph in Cattaraugus county, and near Ellington in Chautauqua county.

Productella lachrymosa, var. lima.

PLATE XXV.

Strophomena lima : CONRAD, Jour. Acad. Nat. Sciences, Philadelphia, Vol. viii, p. 256.

This species is described by Mr. CONRAD as follows :

" Semiorbicular; lower valve ventricose, depressed in the middle, most " profound towards the base; surface with numerous elliptical tubercles " disposed somewhat in quincunx order; umbo ventricose; superior " lateral spaces much depressed. *Locality :* Occurs with the preceding " species [*i. e. P. lachrymosa*, at Chemung-narrows]. Differs from the " last in the depressed middle, much more numerous shorter tubercles, " etc. The size is nearly the same."

Among the collections, and associated with *P. lachrymosa*, are specimens corresponding with this description; but I find so many intermediate forms, that with my present sources of information I cannot regard them as of a distinct species. Characteristic specimens of these are figured in connexion with *P. lachrymosa*. The well-marked specimens are distinctly depressed in the middle, giving the front a sinuate aspect; while the dorsal valves present a corresponding elevation ; the latter showing as a depression in impressions of the interior of the valves, which are often the only condition in which we have them.

In these characters the shell approaches *P. boydii;* but the ventral valve is usually more gibbous, the depression is much broader and becomes obsolete, while the character of the spiniferous tubercles is very distinctive.

Geological formation and localities. In the Chemung group, associated with *P. lachrymosa*, at Randolph and South-valley in Cattaraugus county; Ellington in Chautauqua county, and other places.

Productella lachrymosa, var. stigmata.

PLATE XXV.

SHELL subovoid or hemispheric.

VENTRAL valve ventricose, regularly rounded on the surface, sometimes nearly flat towards the front; hinge-line less than the width of the shell; umbo rounded and much elevated above the hinge-line; apex closely incurved.

Dorsal valve large, somewhat regularly and sometimes deeply concave, but with barely any indication of sudden deflection to the front.

Surface of the casts of the ventral valves finely striate or puncto-striate longitudinally, the puncta more marked towards the base of the valve. The ears are strongly wrinkled, with the bases of several spines upon the folds; these wrinkles extend in obscure undulations across the body of the shell in its upper part. The entire surface is marked by narrow elongate fossets which indicate the places of the spines, the slender bases of which sometimes remain in the depression: in some individuals, there are oval pustules in place of the fossets. There is no appreciable tendency to elongation of these pits or ridges towards the front of the shell; nor does the surface become costate towards the margin, as those which I have referred to *P. lachrymosa* proper, from Chemung-narrows.

The dorsal valves, associated in the same beds, are strongly wrinkled on the ears, with the folds faintly marked on the body of the shell, which is studded with numerous scattered shallow depressions corresponding to the spines on the opposite valve. The cardinal process is distinctly four-lobed.

This is one of the largest forms among the Chemung species; and I am inclined to believe that it may ultimately be proved specifically distinct from *P. lachrymosa*.

Geological formation and localities. In the light-colored sandstones of the Chemung group, near Olean; and in a similar rock at Conewango, and in some decomposing semicalcareous layers at Randolph and East-Randolph, Cattaraugus county, New-York.

Productella speciosa.

PLATE XXV.

Productus speciosus: Hall, in Tenth Report on the State Cabinet, p. 176. 1857.

Shell broadly ovate, subhemispheric; hinge-line less than the greatest width of the shell, the extremities obtusely angular.

Ventral valve ventricose: umbo much elevated above the hinge-line, with the apex closely incurved, regularly arcuate from beak to base and more rapidly curving to the sides, abruptly depressed on the sides of the umbo, and concave between it and the narrow short ears.

Dorsal valve moderately or deeply concave, and more abruptly curving to the front.

Surface of ventral valve marked by fine concentric striæ, and, on the ears, by a few short wrinkles which become obsolete on the sides of the umbo. There are marks of four or five spines on each of the ears just below the hinge-line, and a row of tubercles or spine-bases along the summit of the wrinkles as far as they extend. The body of the shell is covered with as many as twenty-five concentric rows of spiniferous tubercles from beak to base: these are closely arranged, and only become a little irregular towards the front of the shell. The surface of the cast is minutely punctate.

The interior of the dorsal valve is strongly wrinkled on the hinge-margin; and these wrinkles are indistinctly continued across the valve, and studded with numerous concentric ranges of tubercles, which indicate the place of fossets or of spines on the opposite side: the intermediate space is marked by distantly disposed papillæ. The cardinal process is strong at its base, and bilobed above. There are obscure evidences of teeth-sockets.

This species resembles some of the forms of *P. lachrymosa;* but the spiniferous tubercles are smaller, more closely arranged and more numerous, while the umbo of the ventral valve is narrower and somewhat abruptly attenuate. The dorsal valve is studded with numerous tubercles on the interior surface; while in that species the surface is papillose, with indistinct wrinkles and some distant elevations. In *P. lachrymosa*, the divisions of the cardinal process are more divergent, and each division is again bilobed; while in this the divisions appear to be simple.

The species was originally described from a well-formed ventral valve; the same fragment of stone containing a dorsal valve of corresponding character. Numerous individuals among later collections preserve a similar form and expression of ventral valve, but none of them are quite so extremely arcuate. This feature, however, is probably characteristic of the older shells, while the younger ones would acquire this form from continued growth. A careful examination of all the specimens from different localities has shown constant and reliable characters for the determination of the species.

The illustrations show the prevailing differences of form and character among the specimens of this species.

Geological formation and localities. The original specimens are from the Chemung group, on Twenty-mile creek in Chautauque county. It occurs at Leon and New-Albion in Cattaraugus county; and west of Olean in Allegany county, New-York.

Productella striatula (n. s.)

PLATE XXV.

Body of the shell subovate; outline semielliptical, the length equalling or greater than the width: hinge-line equalling, or sometimes a little greater than the width of the shell.

Ventral valve deeply convex, ventricose in the middle and on the umbo, abruptly depressed at the sides and the cardino-lateral angles, forming small ears; regularly arching towards the front, which is more or less produced: umbo elevated above the hinge-line, and the apex closely incurved.

Dorsal valve somewhat deeply concave; the upper part, to near the middle of its length, often slightly concave, and abruptly deflected towards the front: the deflected portion is sometimes more than half the length.

Surface of ventral valve, where the shell is entire, finely striate concentrically, strongly wrinkled on the ears, and the folds usually becoming obsolete on the middle of the shell, but sometimes they are retained in considerable strength. Numerous slender spines are disposed in somewhat regular concentric ranges along the front and middle of the shell, while they are often irregularly disposed and sometimes absent from the umbo and upper middle portions of the shell, but are always present on the ears. When the shell is partially exfoliated, the surface is marked by fine closely arranged radiating striæ. Where the shell is entire, the spines rise almost vertically from the surface, with scarcely elongate ridges at their base, while in the exfoliated surface they leave oval depressions around the spine-bases; but this character is subject to variation from the nature of the matrix.

The interior surface of the dorsal valve only is known; this is finely

papillose or papillose-striate, without evidence, or with very slight evidence of any inequalities of the exterior. (A few gentle pustule-like elevations have been observed in one specimen.) The cardinal margin is wrinkled, and the extremities rounded. There is a short bilobed cardinal process and a slender mesial septum, which reaches half the length of the shell. The occlusor muscular impressions are distinctly visible; and from between them, on each side, proceeds the reniform vascular impression, which is at first slightly inclined forward, and, then curving downwards about half the length of the valve, is again shortly recurved, terminating in a broader expansion, about halfway from the mesial septum to the lateral margin of the valve.

In the specimens examined, this is a neat and well-marked species. The ventral valve, when having few spines, somewhat resembles the young of *P. rarispina;* but it is a more delicate shell, with more slender spines. The shell is thin, easily exfoliated, and presenting a very finely striate surface beneath, or on the partially exfoliated portions. The greater proportion of individuals have the surface pretty evenly studded with spines.

The dorsal valves associated in the same specimens of the rock with the ventral valves are presumed to belong to the same species, and are known by their abrupt deflection towards the front, the finely papillose-striate surface, and absence of pustules or nodes indicating fossets or spine-bases on the exterior surface.

Geological formation and localities. In some semicalcareous bands in the Chemung group at Cherry creek, Chautauqua county; and at New-Albion, Conewango and Coldspring in Cattaraugus county, New-York.

Productella hystricula (n. s.).

PLATE XXVI.

Shell small, concavo-convex, semielliptical : hinge-line rarely equalling and usually somewhat less than the width of the shell.

Ventral valve gibbous or ventricose, somewhat hemispheric, regularly arching, sometimes a little flattened in the middle, abruptly depressed towards the cardinal extremities, and produced in small scarcely defined ears. The umbo is a little elevated above the hinge-line; the apex is often perceptibly truncated, and there is an extremely narrow area.

Dorsal valve moderately or deeply concave, often nearly flat in the upper part, and more abruptly deflected towards the front.

Surface of the ventral valve; near the cardinal angles, marked by a few comparatively strong wrinkles, which are sometimes continued across the body of the shell, or appear as imbricating lines with finer intermediate striæ. These wrinkles are studded with very small slender spines, giving a row along the hinge-margin, and extending in numerous concentric lines over the entire surface of the shell. The inner surface of the dorsal valve is marked by concentric wrinkles and numerous ranges of pustules; but no spines have been observed.

The cast of the ventral valve shows a very narrow area, with a minute central callosity and a bilobed apex, beneath which are cavities from the removal of the teeth. The imprints of the occlusor muscles are narrow elongate scars, and the wide divaricator muscular imprints are rarely faintly preserved.

The spine-bases are seen in the casts as minute pustulose elevations, which become more elongate towards the front of the shell.

The impressions of the exterior of the dorsal valve frequently show a truncation of the apex (more conspicuously than some of the ventral valves, in which the truncation is beneath the arch of the umbo); but this feature does not appear to be constant. There is a pretty strong bilobed cardinal process, with teeth sockets on each side; but no median septum has been observed. The cardinal process, in its exterior impression, shows that each division is grooved, or again lobed. The interior of the valve is minutely papillose, the papillæ becoming elongated towards the front of the valve.

The figures illustrate the prevailing form and size of this species, which occurs in great numbers. Figure 6 is in part a restoration; giving, however, the ordinary length and proportions of the spines. The interior of the dorsal valve, figure 7, is enlarged two diameters.

Geological formations and localities. This species occurs in some hard arenaceous bed, at Forestville in Chautauque county; in a friable sandstone at Conewango, and in some semicalcareous layers at East-Randolph, Cattaraugus county, New-York.

Productella costatula (n. s.).

PLATE XXVI.

Shell subovoid, more or less elongate and often extremely arcuate: hinge-line equalling or less than the width of the shell.

The ventral valve varies from a semielliptical moderately gibbous form in the young, to extremely arcuate in the older shell. The young shells are wider than long, and the older are much longer than wide, but varying greatly in proportions of length and breadth, some of them being extremely narrow.

The surface of the ventral valve is wrinkled on the ears, and closely striate concentrically on the body of the shell. The umbo and upper part of the valve are marked by numerous and regularly disposed elongate spiniferous nodes, which support slender spines. These nodes gradually become more elongated, and, below the middle, the surface is marked by continuous slender costæ, from which, at intervals, rise slender spines. In the young shells, and the upper half of the older ones, the costæ are not present, and a few small but extremely arcuate forms scarcely preserve this marking on the cast; but in the larger specimens, the casts exhibit the costæ in a very marked degree. The casts of the ventral valve are finely puncto-striate.

The dorsal valves which we find associated with the ventral valves described, have been deeply concave; in the upper part they are moderately concave, and more abruptly deflected towards the front. The interior surface only is known, and this presents a short bilobed cardinal process and short slender median septum. The cardinal line is scarcely equal to the greatest width of the shell, and is terminated in short small ears. There are three, four, or five somewhat strong wrinkles on the cardinal margin, which scarcely reach the centre of the shell. The entire inner surface is finely papillose-striate, and shows concentric striæ; while it is thickly studded with pustules, indicating fossets on the exterior surface. These in the upper part of the valve are oval, gradually

elongating, and finally becoming continuous ridges towards the anterior margin of the valve. The area, if existing, is not greater than the thickness of the shell, and no evidence of teeth has been observed.

This species has some resemblance to *P. dumosa* of the Hamilton group; but the costæ are more slender, with fewer and more slender spines. The dorsal valve is very distinctive in its numerous fine pustules on the inner surface. The form of the dorsal valve resembles that of the preceding species (*P. striatula*) in its form, but is at once distinguished by its numerous minute pustules on the inner surface. No reniform impressions have been observed.

In numerous specimens from several localities, this species is very constant and well-marked in its characters. There are, however, a few individuals from a different locality, similar in form, but broader and somewhat flattened or depressed along the middle of the ventral valve, while the surface is much more coarsely pustulose.

Geological formation and localities. This species occurs at Chemung-narrows in Chemung county; Randolph and East-Randolph, Napoli, Conewango, New-Albion, and other places in Cattaraugus county, New-York.

Productella costatula, var. strigata.

PLATE XXVI.

VENTRAL valve wide, a little flattened along the middle from the umbo to the front of the shell, extremely arcuate, broad and rounded near the umbo; the apex closely incurved.

SURFACE of the upper part strongly pustulose in the cast; the pustules elongated in the middle, and becoming continuous costæ towards the front. The dorsal valve, in its interior and casts, is narrowly deflected towards the front, coarsely pustulose above, and costate towards the margin.

These forms approach to *P. arctirostrata* in the ventral valve; but the dorsal valve found associated with that species is very distinct in form and characters. The species, and this variety, bear much resemblance to *P. arcuata* of the sandstones and calcareous beds below the Burlington limestone: the costæ in the ventral valve of that species are stronger and continued nearly to the apex; while the dorsal valve is more nearly flat, and interruptedly costate in its upper part, the deflected portion longer, with the costæ continuous.

Geological formation and locality. This form occurs in some sandy beds of the Chemung group, near Cadiz in Cattaraugus county, New-York.

Productella arctirostrata.

PLATE XXVI.

Productus arctirostratus : HALL in Tenth Report on the State Cabinet, p. 177. 1857.
Compare *Productella shumardiana* of the Hamilton group, page 157 of this volume.

SHELL subovate, extremely ventricose, the proportions of length and breadth variable: hinge-line usually a little less than half the width of the shell.

VENTRAL valve gibbous or ventricose: umbo very prominent and arching over the hinge-line, flattened or slightly depressed in the centre, abruptly depressed at the sides, and extended into short ears at the cardinal extremities.

DORSAL valve moderately concave in the upper part, abruptly deflected towards the front, and following the curvature of the ventral valve.

SURFACE covered by close concentric striæ, with a few strong wrinkles on the ears; and these are more or less distinctly shown, extending across the shell, or marking the surface of the cast. The bases of a few spines are usually seen on the ears of the ventral valve, and the umbo and upper part of the shell are marked by short spiniferous ridges. These ridges become elongated in the lower part of the shell, and are finally almost or quite continuous towards the front. The dorsal valve is similarly marked; the concentric wrinkles extends across the shell, and the spine bases, which are mere nodes in the upper part of the valve, become elongated towards the front.

The casts of the dorsal valve show a bilobed cardinal process, but its character cannot be fully made out. The casts of the ventral valve show small cavities, from the removal of the dental lamellæ, and there is an extremely narrow area visible.

The figures 19–21, illustrate the ordinary form of the ventral valves as they occur in casts in sandstone. Figures 16 and 17, are of the interior, and a profile view of a dorsal valve.

Figures 22 and 23, are of a ventral valve and profile of the same, which is a large and somewhat extravagant form. The flattening of the upper part of the valve is continued in a broad depression to the lower part of the shell.

This species bears some resemblance to the more extreme forms of *Productella shumardiana* of the Hamilton group, but it is a larger and stronger shell and marked by strong concentric wrinkles. The material at my command is not sufficient to make full comparisons.

Geological formation and localities. In the Chemung group, at Jasper in Steuben county, and south of Cadiz.

Productella bialveata (n. s.).

PLATE XXVI.

Shell subovate or subhemispheric; the hinge-line about equalling, or sometimes a little greater than the width of the shell below.

Ventral valve varying from moderately convex to extremely gibbous or ventricose; the greatest elevation being in a vertical line from a point just below the hinge-margin when the shell lies with the opening of the valve downwards, leaving the longest curve of the outline between this point and the front. The umbo is prominent, with the apex closely incurved over the hinge-line. Between the umbo and the cardinal angles the outline is abruptly sloping, or sometimes so depressed as to leave a concave outline at the sides of the umbo. The ears are broad and not strongly defined. In well-marked specimens there is a sinus, which is wider and well-defined on the lower two-thirds of the valve, and can be traced to the umbo.

Dorsal valve moderately concave, and marked by an elevation on the lower half of its length, corresponding to the depression in the ventral valve.

The surface of the ventral valve (judging from the casts) has been essentially free from striæ, except the lines of growth. The ears are marked by two or three or more wrinkles and as many spines, while the body of the shell shows no indications of spines till we approach the margin, where there are or two or three rows of scattered spiniferous tubercles. The dorsal valves examined are not in a condition to enable us to determine whether fossets have existed, corresponding to the spines of the ventral valve.

This species is quite distinct from any of those already described. In its mesial sinus, it resembles the *P. boydii;* but it is usually a much more convex shell, and in all the specimens has fewer spines on the ears, and none upon the middle of the shell. The spines and spiniferous tubercles are likewise of a different character, while the form and expression of the shell is very different. Occurring only as casts in sandstone, the entire characters cannot be ascertained.

Geological formation and locality. In sandstone of the age of the Chemung group, at Meadville, Pennsylvania, associated with *Spirifer disjunctus* and other fossils of the age of the Chemung group.

Productella onusta (n. s.).

PLATE XXVI.

Shell large, broadly semielliptical in outline, the length and breadth about as four to five: hinge-line about equalling the width of the shell, the convexity nearly hemispheric.

Ventral valve regularly convex, depressed-convex in the smaller individuals and ventricose in the older ones, regularly rounded and curving to the front and baso-lateral margins. Body of the shell abruptly curving towards the umbo, which is elevated above the hinge-line, and the apex closely incurved; abruptly depressed, and concave between the umbo and the cardinal extremities, which are produced in ears comparatively wide, nearly flat, and usually a little rounded at the extremities.

Dorsal valve broadly and deeply concave, corresponding to the ventral valve, with the hinge-line comparatively a little shorter.

Surface of the ventral valve with obscure radiating and concentric striæ and a few wrinkles on the ears, which are partially extended to the body of the shell. These wrinkles of the cardinal margins are studded with the bases of slender spines, and the entire surface is marked by concentric rows of similar but smaller spiniferous tubercles. On the shell, these rise almost directly from the surface without any elongation; but where the shell is exfoliated, the remaining pustules are elongate.

The partially exfoliated ventral valve is peculiarly punctate or pitted, as if by the most minute corrugation. The entire cast is puncto-striate, presenting an unusual marking.

The occlusor muscular impressions are well defined, semielliptical and of moderate breadth, appearing to be duplicate; the surface immediately below them is transversely corrugated over a small oval space. The cardinal muscular impressions are wide and comparatively short, flabelliform and deeply striated. The cast of the rostral cavity is grooved on the upper side, and its extremity simple; showing on each side, beneath the apex, cavities made by the removal of the dental lamellæ, while the cardinal line presents no evidence of an area beyond the thickness of the shell.

The interior of the dorsal valve is papillose above, becoming papillose-striate towards the margin. There is a slender mesial septum, which becomes stronger above, and terminates in a short cardinal process: on each side of this are slightly oblique socket-plates, and between these and the hinge-line are narrow teeth-sockets. The cardinal process is distinctly bilobed, and each division is slightly divided or grooved at the extremity. The occlusor muscular impressions are small oval-ovate spots, but are not well-preserved in any specimen seen, yet the reniform vascular impressions are sometimes strongly marked. In addition to the ordinary vascular impression, which terminates abruptly at some distance from the median septum, there is sometimes another mark of similar character beginning at a little distance within the termination of the reniform impression, and curving forward to the termination of the median septum, and thence recurving it terminates on the other side in the same manner as it began, describing part of an elliptic curve.

This shell has a very symmetrical form, and is the largest among the species of this subgenus. It is readily distinguished from all others by its regular wide form and equal convexity, as well as by its distantly disposed and very slender spines, by the peculiar punctate structure of the exfoliated shell, and the striato-punctate surface of the cast.

The form and character of well-preserved specimens are shown in figures 36, 37 and 38, which give the outline, cardinal and profile views of a ventral valve. Figures 39 and 40 are cardinal views of the casts of ventral valves, showing the muscular impressions, and one of them showing on each side of the beak the cavities made by the dental lamellæ.

Figures 30 and 31 are of the interior of two dorsal valves; and figure 32 is a cardinal view, showing the contour of the interior.

Geological formation and localities. This species occurs in the arenaceous and semicalcareous beds at Conewango, at Napoli, and near New-Albion, Cattaraugus county.

Genus Spirifera (Sowerby).

The Genus Spirifera, established by Sowerby in 1815, embraces a very natural group of shells, which are for the most part very readily distinguished by their external form and characters. The presence of internal spires is not alone sufficient to distinguish them, since these organs are common to other very distinct genera.

The prevailing and characteristic form of the shells of this genus is somewhat trigonal; but they vary to subelliptical, ovoid and subcircular in outline. The hinge-line may be shorter or longer than the greatest width of the shell, and the cardinal extremities are sometimes obtusely rounded, and often produced into wing-shaped extensions which terminate in acute points. The surface is smooth, or marked by radiating costæ, presenting a great variety of aspect and ornament; and the centre of the valves is usually marked by an elevated fold on the one valve, with a corresponding sinus in the other: this feature, however, is more or less obsolete in some of the species. The shell-structure is fibrous.

The valves articulate by means of teeth and sockets. The beak of the ventral or larger valve is more or less elevated above the other, and may be straight or recurved. The area or space beneath the beak may be narrow or large, flat or concave, or inclined forwards. This area is divided by a triangular fissure, which is often more or less closed in its upper part by a pseudo-deltidium. In the dorsal valve the area is narrow, usually linear, with a wide fissure, which is partially filled by the cardinal process.

In the ventral valve the triangular fissure is bounded by vertical shelly plates, which extend from the beak to the bottom of the valve, and support, on each side at the base of the fissure, a short and usually strong hinge-tooth. These fissure-walls are usually short diverging plates; but they are sometimes nearly parallel throughout their length, and reach to the middle of the valve. They sometimes converge so as nearly to

coalesce, and again diverge, extending into the interior of the valve and partially surrounding the muscular area. It often happens that the pseudo-deltidium constitutes the exterior indication of the filling of the rostral cavity; and in old individuals, at least, this portion of the shell is quite solid. The occlusor muscular impressions are usually marked upon the inner surface of the shell, and upon the cast, by a mesial longitudinal oval scar; while the divaricator muscular markings occupy a wider space on each side, which is often deeply and beautifully striated. The general interior surface, beyond the muscular impressions, is usually nearly smooth, or marked by the impressions of the external costæ. It not unfrequently occurs, however, that the papillose surfaces, indicating the ovarian spaces, are strongly marked.

There is usually a slight median crest separating the muscular impressions; and in some species this becomes a distinct septum, reaching from the base of the muscular area to the apex of the fissure, as seen in *S. octocostata** (Pal. N. Y. Vol. iii, p. 205).

In the interior of the dorsal valve we have the distinct dental fossets just without the deltoid fissure, which is limited by the bases of the crura proceeding from the cardinal muscular process. The crura, converging at a short distance from their bases, are bent backwards into the cavity of the valve, and again recurved, making several turns, until they are produced into two large conical spires which nearly fill the interior of the shell, the apices being directed towards the cardinal angles. The double occlusor muscular markings are often well preserved in the cavity of the valve and upon the cast of the interior. The impressions of the divaricator muscles are marked upon the median cardinal process, or, in the absence of a distinct process, upon the apex of the notch or upon either side (See Plate 36).

Besides the forms referred to the Genus SPIRIFERA proper, there are at least three modifications of the type which are recognised by Mr. DAVID-

* Mr. DAVIDSON has regarded the presence of a septum dividing the muscular area as characteristic of SPIRIFERINA. In the example cited above, the shell is silicified, and it is not easy to decide positively its texture, but it appears to be fibrous. Should it prove to be punctate and a SPIRIFERINA, it would carry this genus back to Silurian times.

son as subgenera : these are Spiriferina, Cyrtæna and Suessia. Of the first and last of these, we have no recognised species in our Devonian rocks : the Genus Cyrtæna is recognised in two or more species.

The Genus or Subgenus Martinia was proposed by Prof. M'Coy to include species of the type of *Spirifera decora*, *S. elliptica*, *S. glabra*, and others of similar form, having a short hinge-line and rounded cardinal extremities.* In the interior of some species of this type, I have recognized some peculiarities in the dental lamellæ; but the want of specimens for comparison leaves the question undetermined.

The Genus Ambocœlia was proposed by me in 1860, for certain forms having one valve flat or concave, and the other extremely convex. There appear to me to be, in the typical species, some peculiarities in the muscular impressions, which I regard as of importance. The fibrous texture of the shell exhibits some peculiarities; but I find, that in this respect, it corresponds with a small doubly convex form resembling *S. lineata* from the Hamilton group. These forms will be noticed more at length after the descriptions of Spirifera proper.

The following species are arranged upon the plates, as nearly as practicable, in their geological order; beginning with those of the Schoharie grit, and ending with those of the Chemung group. Since many of the species are common to the Schoharie grit and Corniferous limestone, and few of the species pass into the succeeding formations, I shall follow the apparent natural or chronological order in describing them.

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* Mr. Davidson remarks, that "Prof. M'Coy's Genus Martinia was proposed for those species "*in which the hinge-line was shorter than the width of the shell, and dorsal edges of the cardinal area* "*obtusely rounded with a smooth surface, and small spiral appendages;* but the length of the hinge-"line is so very variable, even in specimens of the same species, that on such a character it "seems very unsafe to found a genus. The species are also both smooth and plicated, and the "disposition of the spiral appendages does not appear to be distinguishable from that of other Spirifers. "It will, therefore, be preferable to postpone the adoption of the section *Martinia*, until some more "tangible difference can be pointed out" (Introduction, p. 81, 1854). The same opinions are maintained by Mr. Davidson in his later publications.

SPIRIFERÆ OF THE UPPER HELDERBERG GROUP.

Spirifer duodenaria.

PLATE XXVII & XXVIII.

Delthyris duodenaria : Hall. Geol. Report 4th District New-York, p. 171, f. 5. 1843.
Spirifer duodenaria : Hall, Catalogue in Report on State Cabinet.
Spirifera duodenaria. cited by Billings, Canadian Journal, p. 256. 1861.
" " Geology of Canada, p. 372. 1863.

Shell transverse, semicircular : hinge-line equalling the greatest width of the shell; cardinal extremities obtuse or acute, rarely acuminate. Valves subequally convex; area very narrow. Surface plicated.

Ventral valve moderately gibbous, arcuate, compressed towards the cardinal extremities. Mesial sinus of moderate width and depth, rounded or slightly flattened on the bottom; umbo prominent, the beak small, neatly curved over a wide triangular fissure, and reaching to within half a line of the umbo of the opposite valve : area concave, sublinear, a little wider on each side near the centre.

Dorsal valve regularly convex, a little gibbous in the middle, and flattened or sometimes slightly concave at the cardinal extremities. Mesial fold rather narrow, rounded, prominent and strongly defined, sometimes a little flattened on the middle. The surface is marked by six and rarely seven strongly rounded ribs on each side of the mesial fold and sinus. The ribs gradually decrease in size and prominence from the centre, and the outer ones are often scarcely elevated in young or medium-sized individuals.

The entire surface is marked by lamellose concentric striæ, giving a papillose or subfimbriate aspect at their junction. It usually happens, however, that the surface is smooth from partial exfoliation.

In the Schoharie grit, the cast of the ventral valve shows a somewhat narrow muscular area, with the sides subparallel for half their length and contracting below. There are faint indications of a median crest.

In the interior of a ventral valve from the Corniferous limestone, Plate 28, fig. 23, the muscular area is broad and rounded, with a distinct

median crest. A cast of the dorsal valve shows rather shallow teeth-sockets, with a strong callosity between them and the fissure, while the apex is marked by muscular impressions.

This species has ordinarily a width on the hinge-line of an inch to an inch and a quarter, sometimes reaching an inch and a half; with a length of about three-fourths of an inch, and rarely of larger dimensions. It presents little variety of form and proportions; the younger individuals observed having three or four ribs on each side of the mesial fold and sinus. The cardinal extremities are rarely more extended than in the specimen figured.

In many of its features this species resembles the *S. cycloptera* of the Lower Helderberg group, but it is usually more extended on the hinge-line, with narrower area and less conspicuous surface striæ. In casts of the dorsal valve, however, the two are scarcely distinguishable. It is of the type of *S. speciosa* of Schlotheim, with a narrower area and more ribs than the Eifel specimens, but corresponding in this respect to the English Devonian specimens figured by Mr. Davidson.

Geological formations and localities. This species begins its existence, so far as at present known, in the Schoharie grit, in which it is common in the form of casts throughout the eastern part of the State. In the Corniferous limestone, it is known through all the extent of the formation within the State, and occurs in Canada West, and in Ohio. It is unknown to me in the Hamilton group.

Spirifera macra.

PLATE XXVII.

Spirifer macra: Hall, Tenth Report on the State Cabinet, p. 134. 1857.
" " New Species of Palæozoic Fossils, p. 94. 1857.

Shell transverse, semielliptical, semicircular or subtriangular; hinge-line equalling or greater than the width of the shell below, the cardinal extremities produced into mucronate extensions: valves unequally convex.

Ventral valve more convex than the dorsal, gibbous above the middle, sometimes regularly convex or arcuate, but often less convex on the lower half; compressed towards the cardinal extremities: mesial sinus of moderate width, shallow, but sharply defined at the margins; beak much elevated and slightly incurved over the large fissure; area high, triangular, concave.

Dorsal valve convex, often somewhat flattened, particularly at the sides, and becoming concave towards the cardinal extremities : mesial fold prominent and strongly defined, often much expanded in front; beak small, little elevated, area linear.

Surface marked by from ten to twenty slender well-defined plications on each side of the mesial fold and sinus. In the youngest specimens examined, there are no more than six or eight plications on either side. The entire surface is marked by lamellose concentric striæ, which at intervals are crowded into imbricating lines of growth.

The casts of the ventral valve show the existence of strong short dental plates enclosing a comparatively narrow muscular area. In the middle of this area, in well preserved specimens, are two narrow and much elongated occlusor impressions, with a slight crest between; but these features are often entirely absent or obsolete. The casts of the dorsal valve show large teeth-sockets, and a distinct prominence in the centre for the muscular attachment.

This species has the general aspect of *S. mucronata*, but the plications are a little more prominent, and the concentric striæ less strongly imbricating : the principal point of difference, however, is in the elevated and incurved area of the ventral valve.

The specimens from which the original description was made, were casts of small and poorly preserved individuals; but a larger and more extended collection has shown all the gradations of form, size and condition illustrated on Plate 27, figure 17 being one of the smaller symmetrical specimens. Individuals from the Schoharie grit, and from the limestone, often present considerable differences in the relative convexity of the valves; and the area, either from compression or other causes, shows some apparent variations in its height, as seen in figures 21 and 28, plate 27. In all cases, however, the height of the area is a distinguishing feature. The casts in the Schoharie grit are usually very imperfect and unsatisfactory. The illustrations figures 22, 23 and 24, are from some of the better preserved specimens.

Geological formations and localities. This species occurs in the Schoharie grit in the Helderberg mountains, Albany county, and at Schoharie; and rarely in the Corniferous limestone in the eastern part of the State. It is not uncommon in the Corniferous limestone at Williamsville and other places in the western part of the State, and I have a single specimen from Ohio. Its associates in the Schoharie grit are the *S. duodenaria* and *S. raricosta*.

Spirifera raricosta.

PLATE XXVII & PLATE XXX.

Delthyris raricosta : Conrad, Journ. Acad. Nat. Sci. of Philadelphia, Vol. viii, p. 262, pl. 14, f. 18. 1842.
Delthyris undulatus : Vanuxem, Geol. Report Third District New-York, p. 132, f. 3. 1842.

Shell subquadrate, semicircular or ovate, gibbous : hinge-line equalling the width of the shell or often less; cardinal extremities rounded. Surface strongly plicated.

Ventral valve most gibbous in the upper half, and sloping abruptly to the cardinal angles, which are rarely a little extended and subauriculate : beak much elevated, and always incurved over the area which is variable in elevation, sometimes being barely perceptible, while in others it has a width of from one to two lines, and is marked longitudinally by a few strong striæ. The mesial sinus is a broad rounded depression, and reaches with the adjacent plications quite to the apex.

Dorsal valve gibbous, most convex in the middle, flattened or a little concave towards the cardinal angles. The mesial fold is very prominent and rounded or a little flattened in the middle, regularly arcuate, and forming the small beak which is arched over the linear area.

Surface marked by two to four strongly elevated rounded or subangular ribs on each side of the mesial fold and sinus. In one specimen, I have seen a fifth plication towards the cardinal angle. The entire shell is covered by strong lamellose or imbricating concentric striæ, which are undulated upon the ribs and the intermediate depressions. These concentric lines are sometimes quite regularly equidistant, but often crowded and irregular in their distribution, and more or less prominent at their edges. There are a series of fine closely arranged radiating striæ crossing the concentric lamellæ, and giving in very perfect shells a fimbriate aspect.

The surface is usually more or less worn, and only the stronger concentric lamellæ are visible; and even these are often partially or entirely obliterated. In some specimens, where the shell is well preserved, the plications are rounded and not very prominent; while they become more

distinct, with a subnodose character, on the exfoliation of the shell. The mesial sinus, is usually very wide at its base, sometimes equal to half the length of the shell.

The proportions of the shell are extremely variable, the length being sometimes greater than the width, while usually the width is somewhat greater than the length; and in some individuals the length and breadth are as two to three.

The casts of the ventral valve show a small rostral cavity with short strong dental plates; the muscular area being small, quadrangular, and divided through the middle by a distinct septum.

The interior of the shell of the ventral valve shows short strong hinge-teeth and very short incurving plates below, while the bottom of the cavity is divided by a distinct elevated septum.

The dorsal cast shows marks of dental sockets, with strong muscular markings at the apex of the fissure.

This species is nearly allied with *S. perlamellosa* of the Lower Helderberg group, and is not always readily distinguished from that one. It is, however, usually proportionally shorter on the hinge-line, and more quadrate in form, while it is not known to have as many plications as the older species.

The dimensions vary from half an inch in length and breadth, to an inch and a half in length and breadth; while other specimens are an inch and a half in width by an inch in length.

This species is not common in the rocks of New York, though having a pretty wide distribution.

Geological formations and localities. This shell occurs at the Helderberg mountains and Schoharie, in the Schoharie grit; and in the same region, in the Corniferous limestone. It is known in the latter rock at Stafford, Caledonia, Williamsville in Western New-York; Columbus, Ohio; Falls of the Ohio river; and in several localities in Canada West.

Spirifera grieri.

PLATE XXVII & PLATE XXVIII.

Spirifer grieri: Hall, in Tenth Report on the State Cabinet, p. 127. 1857.
" " " New Species of Palæozoic Fossils, p 87. 1857.

Shell gibbous, transversely oval or subquadrilateral, sometimes longitudinally ovate, the proportions of length and breadth being very variable; hinge-line usually shorter than the width of the shell, with the cardinal extremities rounded: valves subequally convex.

Ventral valve gibbous or ventricose, most convex above the middle and nearly opposite the center of the hinge-line, and sloping very abruptly to the lateral margins; sometimes regularly arcuate in the entire length, and often arched in the upper part and nearly straight below. Umbo prominent and much elevated above the hinge-line: beak more or less extremely incurved over the high arcuate area, which has a length of from one-half to nearly two-thirds the width of the shell; mesial sinus wide and deep, subangular in the lower part.

Dorsal valve regularly arcuate, the greatest convexity near the middle and regularly curving to the lateral margins: mesial fold prominent, sometimes rounded, but usually more or less distinctly angular; beak small, slightly incurved over a nearly vertical narrow area.

Surface marked by six, eight or ten more or less rounded simple plications on each side of the mesial fold and sinus; while there are three or four distinctly bifurcating or dichotomous plications upon the fold or sinus, giving six or seven at the margin of the shell. In perfect specimens, the surface is covered by fine concentric lamellose striæ, which are crossed by delicate radiating striæ.

This species is distinguished from most of the allied forms by its simple strong plications on each side of the mesial fold and sinus, while those occupying the latter are smaller and bifurcating. Sometimes the middle plication on the summit of the mesial fold is simple, in which case the fold is quite angular; while in other instances it bifurcates, leaving a longitudinal depressed line on the middle, giving it a more rounded outline. It is only on specimens which have suffered no injury by wearing or exfoliation, that the fimbriate appearance of the concentric markings is visible.

In some of the larger or older individuals, the plications are low and gently rounded : in other specimens they are more prominent, while from exfoliation they often become angular and more conspicuous ; and the same appears to be true of the dichotomous plications of the mesial fold and sinus. In two or three instances, I have noticed in the casts a partial bifurcation of one or two of the lateral plications. In some of the casts, or partial casts, the plications on the fold or sinus appear to be partly or entirely obsolete. The interior of the valves is unknown.

The specimens before me vary from less than three-fourths of an inch in height and width, to an inch high by an inch or an inch and a half wide. I have seen a single specimen two inches wide, and another of more than an inch and a half in height and width. The illustrations, from figure 17 to figure 23 on plate 28, are of the prevailing forms observed. Figure 29, plate 27, is of a cast from the Schoharie grit.

Geological formations and localities. This shell occurs rarely in the Schoharie grit in the eastern part of the State, and in the Corniferous limestone at Clarence and Williamsville in the western part of the State. I have seen a specimen from Canada West, and it is known to occur at Sandusky and Columbus, Ohio ; while the better specimens have been obtained from the neighborhood of Dayton, Ohio, and were given me by Judge GRIER of that place.

Spirifera gregaria.

PLATE XXVIII.

Spirifer gregaria : CLAPP, MS.
" " HALL, in Tenth Report on the State Cabinet, p. 127. 1857.
Spirifera gregaria : CLAPP, BILLINGS in Canadian Journal, p. 128. 1857.

SHELL ventricose, subglobose, semioval or subquadrate in outline : hinge-line equalling or less than the width of the shell ; cardinal extremities truncate or rounded. Surface plicated.

VENTRAL valve the more gibbous, regularly arcuate from beak to front, the greatest convexity at or a little above the middle, and curving somewhat abruptly to the sides and more gently to the front : beak much elevated, and the apex closely incurved over the fissure ; area high, concave, and extending to the cardinal angles, where it is sometimes more than half a line high, often distinctly striated; mesial sinus rounded or subangular, and much produced in front.

DORSAL valve very convex, with a strong mesial fold, either angular or somewhat flattened along the summit, and sometimes marked by an

indistinct groove : beak often considerably elevated and slightly inclined over the hinge-line; area narrow except in the centre, where it perceptibly widens.

Surface marked by from six to ten strong rounded ribs on each side of the mesial fold and sinus ; the entire surface with undulating concentric striæ, which, towards the front, become strong zigzag imbricating lines.

The interior of the ventral valve presents a well-defined oval muscular impression with a low crest in the centre. The dental plates are often much thickened, filling the entire rostral cavity and encroaching upon the muscular area.

The width of the species ranges from one-half to seven-eighths of an inch, and the length is sometimes a little greater but usually a little less than the width. In the more gibbous specimens, the beak of the ventral valve is so extremely elevated that one-half the length of the valve is above the cardinal line. In the majority of specimens, there are about six or seven plications on each side of the valve. The variable gibbosity of the shell gives an apparent variation in the height of the area, the beaks of the two valves sometimes approaching close to each other.

Some silicified casts of specimens from Indiana, which I have referred with hesitation to this species, have a very symmetrical form : the beak of the ventral valve is moderately elevated ; while the mesial fold is marked by a *distinct* longitudinal groove, and there is a *distinct* angular elevation in the bottom of the sinus. The specimens are extremely abundant in a mass of rock associated with *Strophodonta perplana ;* and in their mode of occurrence have all the appearance of the species as it is found near Louisville, Kentucky.

Geological formation and locality. This species occurs rarely in Upper Helderberg limestone, in Eastern New York, and becomes common in Genesee and Erie counties. It occurs at several localities in Ohio, and at the Falls of the Ohio, both in Indiana and Kentucky. This species has been found in Canada West, and has been described by Mr. Billings among the Devonian fossils from that region.

Spirifera oweni.

PLATE XXIX.

Spirifer oweni: Hall, in Tenth Report on the State Cabinet, p. 129. 1859
" " Description of New Pal. Fossils, p. 89. 1857.

Shell more or less ventricose in its different stages of growth, somewhat transversely oval, semielliptical or subquadrate: hinge-line about equal to the width of the shell; cardinal extremities rounded or subangulated. Surface plicated.

Ventral valve scarcely so gibbous as the dorsal valve, its greatest convexity above the middle of its length, and curving regularly to the margins: beak much elevated above that of the opposite valve, and arching over the fissure, but scarcely incurved; mesial sinus shallow, concave, usually well defined and reaching distinctly to the apex. Area high, concave, elevated and continuing to the hinge-extremities; foramen large, reaching to the apex, and sometimes partially filled by the thickening of the dental plates.

Dorsal valve the more gibbous, the greatest convexity in the middle, and curving regularly to the front and lateral margins, and usually a little flattened or sometimes concave towards the cardinal extremities: mesial fold prominent, rounded, with a longitudinal depressed line along the middle. Area narrow, vertical or in the plane of the longitudinal axis.

The surface is marked by from fifteen to seventeen rounded or subangular plications on each side of the mesial fold and sinus; and these are crossed by distinct concentric striæ, which become strongly imbricating, or are marked in strong imbricating lines of growth towards the margin. In well preserved specimens, there are distinct radiating striæ. In many of the silicified specimens, however, both the radiating and concentric striæ are partially or entirely obliterated.

The interior of the ventral valve shows two short and rather strong teeth, with the rostral portion quite solid. The dental plates, reaching to the bottom of the cavity of the shell, curve slightly outwards and

partially enclose an oval muscular area, which in its upper part is divided by a short prominent median crest. In some silicified specimens, the conical spires are partially preserved. The crura are widely separated at their bases, and, converging somewhat abruptly, curve into the dorsal valve, making twelve or more turns, and producing a short strong spire.

In well preserved specimens, the mesial fold and sinus are usually sharply defined; but in some of the more gibbous forms, the sinus is very broad, and one or two of the plications on each side are involved in the sides of the depression: at the same time the mesial fold is very prominent, rounded, and sloping almost imperceptibly into the general contour of the convexity of the valve.

This species is abundant in the neighborhood of Louisville and other western localities. It has generally been referred to *S. lævicosta*, LAMARCK sp. (*Terebratulites ostiolatus*, SCHLOTHEIM), from which it differs in being less gibbous with a greater number of plications, and in having a depressed line along the mesial fold of the dorsal valve. It may be easily distinguished from *S. euruteines* of OWEN, with which it is associated, by its narrower and much more arcuate area and less angular plications. Some specimens show remains of a faint impressed line along the centre of each plication.

Geological formations and localities. Limestone of the age of the Upper Helderberg: Falls of the Ohio, Charleston landing and other places.

Spirifera acuminata.

PLATE XXIX.

Delthyris acuminata: CONRAD, Annual Report of the Palæontology of New York, p. 65. 1839.
Spirifer acuminatus: (CONRAD,) HALL in Tenth Report on the State Cabinet, p. 135, 1857.
Compare *Spirifer cultrijugatus*, RŒMER in Das Rheinische Uebergangsgebirge, p. 76, pl. iv, f. 4, a, b, c. 1844
Also ? *Spirifer cultrijugatus:* (RŒMER) SCHNUR Palæontographica, Vol. iii, pl. xxiii, f. 1.
" " (RŒMER) DAVIDSON's Monograph of British Devonian Brachiophoda, p. 35.
Also *Delthyris prora:* CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. viii, p. 263. 1842.

" D. ACUMINATA. Shell subcordate, dilated transversely; valves with radiating
" sulci: superior valve very prominent and carinated in the middle; carina
" not sulcated, slightly arcuate in length; lateral extremities rounded; base
" emarginate; inferior valve profoundly bilobed; sulci not deeply impressed;
" beak approximate. Length 2½ inches. *Locality:* Helderberg, in limestone.
" It resembles *Atrypa acuminata* (SOWERBY).

Shell large, ventricose, transverse, with the hinge-line usually less than the width of the shell; cardinal extremities rounded or truncate, having a subelliptical or subquadrate outline; mesial fold and sinus extreme. Surface plicated.

Ventral valve variably convex on the two sides, with a wide mesial sinus, which is well defined in the upper part, becomes wider and deeper and less distinctly defined in the middle of the shell, and is produced in front into a long triangular extension; gently or more abruptly curving from the greatest convexity to the sides and cardinal angles: umbo prominent, with the apex incurved over the wide triangular fissure; area extending to the cardinal angles, with the margin rounded except towards the extremities.

Dorsal valve gibbous, highly elevated in the middle into a strong angular mesial fold, and curving from the sides of the fold to the margins of the shell, except at the cardinal angles, where it is a little flattened and projecting, so as to give a minute auriculate appearance; summit of the mesial fold regularly arcuate from beak to base; apex slightly incurved over the narrow nearly vertical area.

Surface, on either side of the mesial fold and sinus, marked by from sixteen to twenty plications, about four or five of which nearest the centre are dichotomous from below the middle of their length; ribs low, and rounded above, flattened below the middle, those towards the margin very slender: the first ten or twelve ribs on each side occupy the greater part of the valve. The entire surface is marked by delicate concentric striæ, which are often crowded into imbricating lamellose lines towards the front of the shell. In very perfect specimens, these concentric striæ are papillose or fimbriated by fine radiating striæ. These fine surface markings, however, are usually nearly or quite obliterated.

The interior of a ventral valve shows but a partial thickening of the shell in the rostral cavity: the teeth are strong and short; the dental plates spreading and margining the upper part of the ovate muscular

area, which is broader above, and sometimes very much resembles this feature in *S. striatus*.

The casts preserve strong and prominent marks of the muscular impressions, and sometimes vascular markings outside of the muscular area; while in other individuals, the papillose ovarian markings are very distinctly preserved. In the cast of the dorsal valve there are sometimes strong impressions of the occlusor muscular markings, and the apex also shows the striæ of the cardinal muscular attachment.

It does not appear, from Mr. CONRAD's description, that he recognized the dichotomous ribs; but this feature is often obscure or scarcely recognizable in the specimens from the Corniferous limestone in New York, owing to partial exfoliation or other causes; and in most of the smaller specimens it does not exist, the division usually taking place below the middle of the length. In full grown individuals, when the surface is pretty well preserved, the duplicate character of the plications is a conspicuous feature. Somewhat rarely we observe a partial division of one or more of the plications on different parts of the shell towards the margin.

A Spirifer in the Hamilton group, which I have identified as the *Delthyris prora* of CONRAD, is clearly identical with this one of the Corniferous limestone. The dichotomous character of the ribs, however, is more conspicuous, and the division often begins above the middle of the shell (See fig. 24, pl. 34), and becomes a conspicuous feature in specimens of medium size; while in those of similar dimensions from the Corniferous limestone, this character is scarcely perceptible.

This species is readily distinguished from all the other SPIRIFERA in our strata, by the extremely elevated angular mesial fold and deep sinus, which are bounded by the dichotomous plications. In an imperfect condition, it might be sometimes mistaken for *S. macrothyris*, which, in its hinge-area and the upper part of the mesial fold, sometimes simulates the *S. acuminatus*.

The young of this species are but moderately convex, with a broad depression in front, as shown in fig. 9, pl. 29. From this condition, there are all degrees of variation to the more ventricose and extreme forms as shown in figs. 12, 13 and 14, of Plate 29.

The casts show considerable variation in the form and proportions of the muscular area, two examples of which are shown in figures 15 and 16, Plate 29.

The cast of a ventral valve, Plate 34, figure 25, illustrates the character of a well-preserved specimen from the Hamilton group.

This species has been recognised by Dr. F. Rœmer and M. de Verneuil as identical with the *S. cultrijugata* of Europe. Without the means of comparing specimens, I had supposed the American and European species to be identical; but Mr. Davidson has recently called attention to the existence of bifurcating ribs in the American species, while "in all the figures published by Rœmer, Schnur, " and Sandberger of *S. cultrijugatus*, the ribs on the lateral portions of the shell " are simple, and do not exceed about twenty on each valve; but in a specimen so " named in my possession from the Falls of the Ohio near Louisville, in America, " and which I received likewise some years ago from Herr F. Rœmer, the ribs are " small, and in some places bifurcated, and numbering about twenty-four in each " valve."

The original figures of Dr. Rœmer represent the species with simple strong rounded ribs on each side of the mesial fold and sinus; while the elevation in front is triangular as in our specimens. In the figures of Schnur,* the sinus in front is not triangular, but the sides approach to parallel, and the summit is arched rather than angular. It appears to me, however, that M. Schnur has indicated something like a bifurcation, or a depression along the centre of the larger plications, in figures 1 *a*, *b*; though it must be confessed that the general expression of the figures is somewhat different from our shell. The figures given by Mr. Davidson (loc. cit.), and referred with doubt to this species, have "six or seven " strong simple ribs on each of the lateral portions of the valve." This feature would preclude its association with our specimens, and indicates a nearer approach to some of the forms which I have referred to *S. macrothyris*.

Mr. Conrad has given the length of *S. acuminatus* as $2\frac{1}{2}$ inches. The specimens before me vary from one inch to two and a quarter inches in width, and from three-fourths of an inch to an inch and seven-eighths in length.

Geological formations and localities. This species is not known below the Corniferous limestone, where it has been found in Albany and Schoharie counties, as well as at several localities in the central part of the State, and at Williamsville and Clarence-hollow in the western part of the State. It occurs in the same formation at Sandusky and Columbus, Ohio; at the Falls of the Ohio both in Louisville and Jeffersonville, and at Camp creek, Indiana. It is found in the Hamilton group

* Palæontographica, T. iii, pl. xxxiii, f. 1, *a*, *b*, *c*.

in Schoharie and at Hamilton, Cazenovia and Madison (Madison county); but is unknown in this formation in the western part of the State. There is a cast of this species in the cabinet of Marietta College, Ohio, which, I infer from its character, has been derived from the southwestern extension of the Hamilton group, perhaps in Virginia.

Spirifera macrothyris.

PLATE XXX.

Spirifer macrothyris: HALL, Tenth Report on State Cabinet, p. 132. 1857.
" " Description of New Pal. Fossils, p. 92. 1857.

SHELL large, moderately gibbous, transverse, semielliptical, the width a little more or less than twice the length: hinge-line equal to the greatest width of the shell; cardinal extremities rounded or angular, and produced. Surface plicated.

VENTRAL valve less gibbous than the dorsal, regularly arcuate from front to beak, and curving gently to the lateral and cardinal margins: sinus well defined above, and reaching to the small and neatly incurved beak, becoming wider and deeper below and much extended in front. Area concave, of moderate width, and extended to the cardinal extremities; margin angular: fissure very large.

DORSAL valve the more convex, the greatest convexity about the middle of its length: mesial fold prominent, angular in its upper part and rounded towards the front, giving a highly arcuate outline to the margin; umbo much elevated and rising nearly as high as that of the opposite valve; beak incurved over the nearly vertical area, which is about a line in width.

The surface is marked by about ten or twelve strong low rounded plications on each side, which are simple from their origin, becoming less prominent towards the margin of the shell: the first five or six on each side of the fold and sinus occupy the greater part of the anterior margin. In well preserved specimens the surface is marked by fine closely arranged concentric striæ, which are finely papillose from radiating striæ. The cast of the ventral valve presents a large ovate bilobed muscular impression.

This is a fine robust species, of which I have before me a dozen specimens in various states of preservation, and presenting, in some respects, variations which make me hesitate in referring them all to the same. In some which appear to be well preserved, the area is comparatively narrow, while in others it has a proportionally greater width. The plications also appear to be of variable strength, and in some of the casts are much stronger than in the shells. In the larger individuals, the general characters are strongly defined, as shown in figures 16, 17 and 18, Plate 30; while the individual figure 19 was for a long time placed among specimens of *S. acuminata*, owing to its prominent angular mesial fold, and form of area, which correspond to that species; but in the curved instead of angular sinus in front, and in the details of the plications, the two are quite distinct. In the more minute surface markings, the concentric striæ of *S. acuminata* are coarser, and the radiating striæ more frequently interrupted; but this feature may not prove constant. In its entire form and full proportions it is not likely to be confounded with any other species of the higher formations.

In some of the casts of this species, we have very nearly the characters represented in the figures of *S. cultrijugata* given by Mr. Davidson,* except that the area is not so elevated in the middle.

Geological formation and localities. This species occurs in the Corniferous or Upper Helderberg limestone at Williamsville and Clarence-hollow, New-York; and near Columbus, Ohio.† It is unknown to me in the eastern part of the State of New York.

Spirifera unica (n. s.).

PLATE XXX.

Shell semielliptical; length and breadth about as seven to ten. Surface finely plicated.

Ventral valve moderately gibbous, with a broad deep sinus which is undefined at its margins; umbo prominent, much elevated above the hinge-line, with the beak extremely incurved: outline curving gently from the umbo to the front, and more abruptly to the lateral margins, being concave between the umbo and the cardinal extremities. Area rather low, concave, and scarcely extending to the cardinal angles.

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* Monograph of British Devonian Brachiopoda. Plate viii.

† Specimens were obtained from Dr. R. P. Mann, of Milford, Ohio.

The surface is marked by about twenty or twenty-one somewhat slender low rounded simple plications on either side; while the mesial fold has seven or eight plications in its upper part, which bifurcate, and become twelve or fourteen at the anterior margin. The entire surface is marked by fine radiating striæ, and imbricating lines of growth near the margin.

This species has been observed only in a single imperfect ventral valve; but its characters, in the individual, are quite distinct from any other species in this formation; the lateral plications are more numerous than in any other, with a low area, while the bifurcating plications of the sinus furnish ready means of distinguishing it from any other except the *S. arenosa*, which has a much more shallow sinus with less elevated beak and broader umbo. The plications are likewise more slender than those of that species in the Oriskany sandstone, and the surface is marked by fine radiating striæ, a feature which I have not observed in that one.

This species differs from *S. divaricata* (which has likewise plications in the sinus) in the general contour of the shell, the deeper sinus and the simple plications on the lateral portions of the shell, as well as the more minute surface marking, which is quite distinctive.

Geological formation and locality. In the Corniferous limestone, near Clarence hollow, Erie county, New-York.

Spirifera disparilis.

PLATE XXX.

Spirifer disparilis: Hall, Tenth Report on the State Cabinet, p. 134. 1857.
" " Description of New Species Pal. Fossils, p. 94. 1857.

Shell small, somewhat semielliptical; length and breadth about as two to three or three to four: hinge-line a little less than the greatest width of the shell; cardinal extremities rounded.

Ventral valve gibbous, extremely elevated towards the umbo, abruptly curving to the front, and sloping in a nearly straight or slightly concave line to the cardinal extremities: sinus deep and angular; beak extremely elevated, and abruptly incurved over the high narrow fissure. Area high, triangular; margin rounded, the width about twice the height.

Dorsal valve moderately convex or nearly flat, with beak little elevated and not incurved : area narrow and straight ; mesial fold smaller than the adjacent plications.

The surface is marked by five or six obtusely subangular plications on the ventral valve, there being sometimes an unequal number on the two sides. The plications of the dorsal valve are broader and rounded, not reaching to the apex ; the mesial fold being smaller than the adjacent plications, depressed below their plane, and the sinus on each side wider than the fold itself. The plications on each side of the sinus of the ventral valve are much stronger than the others, and reach to the beak, while the others do not. The finer surface markings are unknown, all the specimens seen having been exfoliated.

This species is readily distinguished from all the others in our strata, by the extreme disparity of the valves, and the broad and short plications, while at the same time it has not the characters of Cyrtina.

The figures of this species are enlarged to two diameters.

Geological formation and locality. This species is only known to me in the Corniferous limestone in the neighborhood of Williamsville and Clarence-hollow, Erie county, New-York.

Spirifera varicosa.

PLATE XXX.

Spirifer varicosus : Hall, Tenth Report on the State Cabinet, p. 130. 1857.
" " Description of New Pal. Fossils, p. 90. 1857.

Shell somewhat semicircular or semielleptical ; length equalling or less than half the width : hinge-line equal to the greatest width of the shell, and terminating in salient angles or mucronate extensions. Surface plicated.

Ventral valve much the more convex ; greatest elevation at the umbo, and regularly curving to the front and lateral margins : mesial sinus strongly defined, rather flat in the bottom ; beak slightly arcuate. Area high, nearly flat below and slightly concave towards the apex.

Dorsal valve moderately convex, with a prominent abruptly elevated mesial fold, which is flattened on the summit and sometimes slightly

depressed along the centre; the beak projecting a little above the hinge-line, and with a narrow area gently incurved.

The surface is marked by from eight to ten simple and somewhat abruptly elevated plications on each side of the mesial fold and sinus: these are crossed by strong lamellose imbricating lines of growth, which give a varicose character to the surface, and where the shell is exfoliated the plications are nodose.

In some specimens, distinct fine radiating striæ can be observed. There is often a retral curving of the concentric striæ in the centre of the mesial sinus, and sometimes a slight elevation along that line.

The original specimens of this species were obtained from a western locality; but there are forms in Western New-York, which, though differing slightly from the originals, seem nevertheless referable to the same species.

In comparing this with other generally similar forms, I remarked in my original description that this species differs from *S. curuteines* of Owen, in being smaller and more transverse, with more angular plications and stronger concentric lines of growth; also, in the greater prominence of the two plications bounding the sinus, as well as the abrupt and angular mesial fold. It differs from *S. segmenta* in its fewer and more rugose plications, as well as in the more abrupt mesial sinus, and in the inclination of the area.

The figures 1-4, Plate 31, are of typical forms of this species, of which I have more than a dozen individuals before me, all preserving the same characters without material variation.

Geological formation and locality. In limestone of the age of the Upper Helderberg limestone at Charleston landing, Indiana; at Williamsville, etc., New-York.

Spirifera varicosa, var.

PLATE XXXI.

Shell having the general characters of *S. varicosa*, but larger and more gibbous; area higher, but similarly arcuate in the upper part. There are ten or more plications on each side, which are rugose from strong imbricating lamellæ, and become somewhat nodose on partial or entire exfoliation. Unfortunately only a few specimens of this variety have been seen in New-York.

Figure 23, Plate 31, illustrates the ventral valve of an individual of this species. From the conditions of preservation, it does not represent the full length of the valve in proportion to the width. Mr. BILLINGS has recognized a similar form in Canada West, which he compares with *S. mucronata*. Our specimens are very unlike *S. mucronata*.

Geological formation and locality. In the Upper Helderberg (Corniferous) limestone, near Williamsville, New-York.

Spirifera segmenta.

PLATE XXXI.

Spirifer segmentus: HALL in Tenth Report on the State Cabinet, p. 131. 1857.
" " Description of New Pal. Fossils, p. 91. 1857.

SHELL transverse, semioval; length less than half the width: hinge-line equalling the greatest width of the shell, and terminating in salient angles. Surface plicate.

VENTRAL valve much elevated, subpyramidal, most prominent at the beak, which is not incurved: sinus strongly defined, shallow and nearly flat in the bottom, with the sides straight, giving a triangular form, in which the sides are about once and a half as long as the base. Area very large with sharply angular margins, a little inclined forward, and nearly of the same size as the exterior of the valve: the fissure is high and large, being nearly of the same dimensions as the mesial sinus.

DORSAL valve depressed convex, and flattened towards the cardinal extremities, larger than the ventral valve, semielliptical in form, with a low but sharply defined mesial fold which is barely flattened upon the summit. The proportions in height of area, length of dorsal and length of ventral valves, is about as five, six and seven.

SURFACE marked by twenty or more simple rounded (or subangular) plications on each side of the mesial fold and sinus, the lateral ones of which do not reach the beak, but run out along the margin of the
In its perfect condition the shell has been marked by fine concentric striæ, traces of which are still preserved, together with stronger imbricating lines of growth.

This species is associated with *S. varicosa;* but may be distinguished from that one by the more numerous and smoother plications; a more depressed, smooth and rounded mesial sinus; the anterior inclination of the area, and the proportionally greater length of the ventral valve, (which is a little greater than the dorsal valve in that species,) and much greater than the height of the area.

It also bears some resemblance to *S. euruteines* of Owen; but in that one the area is vertical and considerably less in height than the length of the ventral valve, and the latter is longer than the dorsal valve; and although a smaller shell, the *S. segmenta* has more numerous plications than *S. euruteines.* Its nearest analogue is the *S. angusta* of the Hamilton group.

The figures 5, 6, 7 and 8, Plate 31, illustrate the form and proportions of this species: the cardinal extremities have been broken off.

Geological formation and locality. In limestone of the age of the Upper Helderberg, at the Falls of the Ohio, and at Charleston landing, Indiana.

Spirifera arctisegmenta.

PLATE XXXI.

Spirifer arctisegmentus: Hall, Tenth Report on the State Cabinet, p. 131. 1857.
" " Description of New Pal. Fossils, p. 91. 1857.

Shell transversely semioval; length less than one-third the width: hinge-line equal to the greatest width of the shell, and terminating in mucronate points.

Ventral valve the more convex, most prominent at the umbo, from which it slopes regularly to the anterior and lateral margins: mesial sinus angular, and distinctly defined quite to the apex of the shell; beak not incurved. Area flat, a little inclined forwards, striated longitudinally; fissure narrow and open to the apex.

Dorsal valve depressed convex, scarcely flattened towards the cardinal extremities: the beak and central portion of the shell, together with the linear area, slightly incurved.

The surface of the ventral valve is marked by eight or nine angular plications, which are slightly curved towards the front, and about three of them only reaching the apex; the remainder coalesce with an elevated ridge which borders the area. The plications on the dorsal valve are pretty direct, the greater part of them terminating in the margin at a

distance from the beak. Fine close concentric undulating striæ mark the entire surface.

This shell may be distinguished from the last, as well as from other somewhat allied forms, by its larger and more angular as well as less numerous plications, and in having a distinct linear ridge along the margin of the area of the ventral valve : its foramen is likewise narrower, and the sinus deeper and more angular than in *S. segmenta.*

The individuals observed are too few to determine what changes may supervene from age and surrounding conditions ; but with our present knowledge, it cannot be united with any other similar form described.

Figures 9 and 10, Plate 31, are illustrations of the original specimen described.

Geological formation and localities. In limestone of the age of the Upper Helderberg group, at Stafford, Genesee county ; and at Shortsville, Ontario county, New-York.

Spirifera curuteines.

PLATE XXXI.

Delthyris (Spirifer) euruteines : Owen, in Report of Geological Explorations in Iowa, Wisconsin and Illinois for 1839,* p. 74, f. 9, Plate 12.

Spirifer euruteines : Owen, Geological Survey of Wisconsin, Iowa and Minnesota, p. 586, Tab. iii (excluding figures 2 and 2 *a*), figures 6, 6 *a*, *b*.

Shell semielliptical; length and breadth about as six to ten : hinge-line equal to the greatest width of the shell. Surface plicate.

Ventral valve subpyramidal, the elevation being nearly equal to half the width, curving abruptly and equally to the front and lateral margins ; the distance from the apex to the cardinal extremity and to the front of the shell being about equal. Apex sometimes projecting slightly over the area : mesial sinus shallow, well defined, and reaching to the apex, sometimes a little flattened in the bottom. Area extremely elevated, nearly flat or slightly concave above; fissure large and open to the apex, the length of the sides being about once and a half the width at the base.

" * Report of a Geological Exploration of Part of Iowa, Wisconsin and Illinois, made under instructions from the Secretary of the Treasury of the United States in the autumn of 1839 ; with charts and illustrations. By David Dale Owen, M. D., Principal Agent to explore the mineral lands of the United States. Ordered to be printed, by the Senate of the United States, June 11, 1844."

Dorsal valve moderately and evenly convex with a well-defined low rounded mesial fold; beak, and margin of the valve in the middle, slightly arched. Area narrow at the sides, but having the width of a line in the middle.

Surface marked by from sixteen to twenty plications on each side of the mesial fold and sinus: these plications are rounded and well defined; about eight of them reach the apex on the ventral valve, and the remainder coalesce with the angular border of the area. In perfect specimens the entire surface has been covered by fine concentric undulating striæ, which are crossed by fine radiating striæ. The remains of these, upon some of the silicified specimens, give a granulose surface.

The length of full grown individuals is a little more than three-fourths of an inch, with a width of about an inch and three-eighths: the height varies from three-fourths of an inch to a little less.

I have before me more than a dozen specimens from near the Falls of the Ohio or from Charleston landing, among which there is very little variation in the general features. The smallest individual of these has a length of a little more than half an inch.

Dr. Owen first noticed this species in his Report in 1839. In 1841, I received specimens from him with this name attached; and during many years, so far as I know, the specimens from the Falls of the Ohio and from Charleston landing were the only ones distributed under this name. In his Catalogue of Species, appended to the Geological Report of Wisconsin, Iowa and Minnesota, page 628, Dr. Owen cites as localities "Pine creek; Davenport; below Rockingham; New-Buffalo; Rapid creek; Wapsinonox;" and "elsewhere in the United States, Columbus, Ohio; Charleston landing, Indiana; Falls of the Ohio."

The figures 6 *a*, *b* (*ut cit.*) appear to me to be of the typical form, and may have been made from Indiana or Ohio specimens; but certainly figures 2 and 2 *a* are not of the same species. I have not seen specimens from Pine creek or elsewhere in Iowa, which I regard as identical with those of Charleston landing, although such may occur. I can only suppose that the similarity of form may have misled Dr. Owen, and induced this reference; but I believe it will be more just and more satisfactory to retain the name *S. euruteines* for the species to which it was originally applied by Dr. Owen himself.

Figures 14, 15, 16 and 17 of Plate 31 represent the characteristic features of this species from the localites cited below.

Figure 18 is a ventral valve with the dorsal valve removed, except at the apex, and showing the disposition of the crura and spiral arms.

Figure 19 is a cardinal view of a smaller individual.

Geological formation and localities. In the limestone of the age of the Upper Helderberg group, at Columbus, Ohio; Falls of the Ohio (Louisville and Jeffersonville), and at Charleston landing, Indiana.

Spirifera euruteines, var. fornacula.

PLATE XXXI (figures 11, 12 and 13).

Spirifer fornacula: HALL, Tenth Report on State Cabinet, p. 154. 1857.
" " Description of New Pal. Fossils, p. 114. 1857.

This species possesses the essential characters of *S. euruteines*, with the area a little more arcuate in the upper part; while the relative strength of the plications offer no characters of specific importance: there are, in one specimen, nine, and in another ten, in the space occupied by eight plications in *S. euruteines* proper.

In casts of this variety, the mesial fold is flattened on the summit and grooved towards the upper part, and the sinus is more distinctly flattened on the bottom. In one specimen the cardinal angles are produced and mucronate; but this may likewise occur from the different surrounding conditions.

The figures 11, 12 and 13 are representations from a specimen heretofore described under the name of *S. fornacula*.

Geological formation and locality. This form occurs in limestone of the age of the Hamilton group, and perhaps also in Corniferous limestone, at the Bake-oven, on the Mississippi river, Illinois.

Spirifera manni.

PLATE XXXI.

Spirifer manni: HALL in Tenth Report on the State Cabinet, p. 128. 1857.

SHELL semielliptical or subquadrate; valves very unequally convex: hinge-line equal to the greatest width of the shell; cardinal extremities angular, and sometimes produced in acute extensions.

VENTRAL valve subpyramidal, the height often nearly equal to two-thirds the length; greatest elevation at the apex, and thence curving to the front and lateral margins; mesial sinus angular above, and rounded or

flattened toward the front; margins angular and sharply defined. Area large and high, flat and inclined a little backwards or slightly concave; foramen large and open to the apex.

Dorsal valve more or less gibbous and sometimes only moderately convex, curving to the front and lateral margins, and a little flattened at the cardinal extremities; mesial fold moderately elevated, strongly defined, and flattened or concave on the summit: the beak and adjacent portion of the margin is more or less arcuate, and the area is concave for more than half its length on each side of the centre.

The surface is marked by ten or twelve plications on each side of the mesial fold and sinus; the plications rounded or subangular, and sometimes subnodose on exfoliation. Portions of the shell preserved on some of the specimens show strong lamellose concentric striæ, with faint radiating striæ.

All the specimens which have come under my observation are more or less imperfect, and in the condition of partial or entire casts.

The figures 20, 21 and 22 are from a typical specimen of this species, from which the shell has been mainly exfoliated.

Figures 24 and 25 are of a specimen from near Williamsville, New-York, which has similar proportions and the same number of plications; but these are subangular and a little nodose, while the mesial fold is more distinctly depressed in the centre.

In some respects this form resembles *S. varicosa;* but though much larger, it has fewer plications.

There is another form much less gibbous and more extended on the hinge-line than the two preceding specimens; of this, a large individual is illustrated in figures 26–30. The proportion of area and length of shell are similar, the mesial fold is flattened or concave on the summit, and the number of plications is the same: it differs only in the lesser gibbosity of the dorsal valve and the greater extension of the hinge-line.

Geological formation and localities. The specimens from which this species was originally described were from Ohio, occuring at Sandusky and near Columbus. In New-York, it is found at Williamsville, in the Corniferous limestone.

Spirifera divaricata.

PLATE XXXII.

Spirifer divaricatus : HALL, Tenth Report on the State Cabinet, p. 130. 1857.
" " Description of New Species Pal. Fossils. p. 93. 1857.
Spirifer venustus : HALL, Thirteenth Report on State Cabinet, p. 82. 1860.

SHELL ventricose, somewhat rhomboidal or quadrilateral (looking upon the ventral valve). Dorsal valve semielliptical : hinge-line less than the width of the shell; cardinal extremities obtuse or rounded; area large.

VENTRAL valve most convex above the middle, extremely arcuate from the umbo to the base, abruptly curving to the sides : beak abruptly arching over to the area; sinus plicated, shallow above and becoming rapidly expanded below, with the margins undefined and terminating in a broad triangular extension in front. Area high, flat below, abruptly arcuate above, and reaching to the cardinal extremities : foramen large.

DORSAL valve regularly and strongly convex, with an angular mesial fold, which is narrow above and expands towards the front, with bifurcating plications; sides regularly curving, and sometimes a little flattened towards the cardinal extremities. Area rather wide, with the beak and central portions of the valve arching over it.

The surface is marked by numerous fine bifurcating rounded or subangular plications; the mesial sinus having on either side a stronger plication, which bifurcates on one or on both sides. At the beak there is a single plication in the bottom of the sinus, which sometimes continues simple nearly or quite to the base; while the accessions take place mainly from those on the sides of the depression, till they reach the number of ten, eleven or twelve within the limits of the sinus near the base. In a specimen of ordinary size, where the surface is well preserved, there can be seen sixty or more plications with their divisions at the margin of the shell. In some specimens from the Corniferous limestone,

where the surface is partially or entirely exfoliated, the bifurcating character of the striæ is not observed; and in one specimen, they appear to have been nearly simple throughout.

The plications are crossed by fine imbricating lamellose striæ, which are abruptly arched backwards.

A cast of the ventral valve shows a large oval muscular area, which is deeply divided by a rounded median crest, and strongly striated on the lateral portions.

After examining all the collections that have been made, I am unable to point out any specific difference between the specimens originally described by me as *S. divaricatus*, and those subsequently described as *S. venustus*, from the Hamilton group. The specimens then before me were in the condition of the one figured on plate 32 figure 1; while the Hamilton specimens, illustrated in figures 2–6, offered at first view very little similarity with those of the limestone, and were regarded as a distinct species. Other specimens from the limestone have a nearer approach to those of the Hamilton shales.

This shell, in its proper form and proportions, is one of the finest Spirifers in the whole series, and is readily distinguished from all others by the bifurcating plications and sharp zigzag concentric striæ. The largest specimen seen has a width of nearly three inches with a length of two inches, and a depth of one inch and an eighth.

Geological formations and localities. In the Corniferous limestone at Schoharie; at Stafford in Genesee county; at Williamsville and Clarence in Erie county. In the Hamilton group, at York, Livingston county. I have seen a fragment of this species from the limestone near Port Colborne, Canada West.

Spirifera fimbriata.

PLATE XXXIII.

Delthyris fimbriata: Conrad, Jour. Acad. Nat. Sciences Philadelphia, Vol. viii, p. 263. 1842.
Spirifer fimbriata: Conrad; Billings in Canadian Journal, p. 259. 1861.

Shell transversely subelliptical, gibbous: hinge-line less than the width of the shell; cardinal extremities rounded.

Ventral valve gibbous in the upper half, regularly curving to the front and sides; sinus well defined, usually shallow and rounded, sometimes deep and angular, and much produced in front; beak small and incurved over the area, which is high and concave and extending

about half the entire width of the shell : foramen often limited by a sharp elevated border, which appears to be a projection of the dental plates.

Dorsal valve gibbous, regularly convex on the sides, a little flattened at the cardinal extremities ; mesial fold abruptly elevated in the lower part, often but little elevated or scarcely defined in the upper part ; beak small, slightly arched over the sublinear area, which is somewhat concave.

Surface marked by from three or four to eight or nine low, rounded, often obscure plications on each side : these are crossed by imbricating lamellose striæ, which are sometimes wide or distant, and often crowded. The concentric striæ are studded with elongated nodes or tubercles, which are thus arranged in parallel bands, more or less contiguous, according to the distance of the concentric stiæ.

The elongate tubercles may perhaps more properly be regarded as interrupted radiating striæ, which, in the perfect condition of the shell, have doubtless extended in slender spines or setæ. (They are termed by Mr. Conrad short longitudinal striæ.)

The area is strongly striated vertically.

It has been impossible to obtain the means of a satisfactory study of the interiors of these shells. A cast of the ventral valve from the Schoharie grit has a deep and subangular sinus and the costæ rather strongly marked, with a subovate muscular area which is depressed in the centre with linear elongate occlusor imprints, and cavities at the sides showing short strong dental plates.

In another cast from the Hamilton group the muscular area is narrower, the dental plates longer and thinner, with faintly marked ribs, and there is evidence of a distinct median septum. The surface of the cast in both valves is strongly marked by vascular impressions.

This species begins its existence (so far as we know) in the Oriskany sandstone, where it has been rarely observed. It occurs in the Schoharie grit, and reaches its greatest dimensions in the Corniferous limestone ; having often a width of nearly or quite two inches, with a length of an inch and a quarter. It is often well preserved in the Hamilton group ; but in this formation, it rarely attains a width of an inch and a half. It is not known in the Chemung group, though there is a representa-

tive form in that epoch. The species has a wide geographical range, being known throughout New-York, Canada West, Ohio, in the Mississippi valley, and as far south as Virginia.

The *S. fimbriata* is the first of this type in our formations, but is represented by similar forms* to the close of the Carboniferous period.

In the illustrations of these species, the fragment 1 is from the Oriskany sandstone the figures 2, 3 and 4 are from the Schoharie grit; figures 5–11 are from the Corniferous limestone: the remaining figures are from the Hamilton group.

Geological formation and locality. This species occurs in the Oriskany sandstone at Saugerties in Ulster county, and at Knox in Albany county, and probably in Schoharie. It is found in the Schoharie grit in Albany and Schoharie counties, and in the Corniferous limestone in the same region; and at Cherry-valley; Westmoreland, Oneida county; Onondaga-hollow, Onondaga county; Stafford, Genesee county; Williamsville, Clarance, and other places in Erie county; in Canada West, and at Columbus and other places in Ohio.

In the Hamilton group, it occurs on the shores of Seneca and Cayuga lakes, and upon Canandaigua lake; at York and Moscow in the Genesee valley; and at Darien; at Eighteen-mile creek, and other places in Erie county. Also in the same group in Maryland and Virginia; and at Davenport and New-Buffalo, Iowa; at Rock-island, Illinois; and elsewhere in the Mississippi valley.

Spirifera mucronata.

PLATE XXXIV.

Delthyris mucronata: Conrad, Ann. Report on the Geology of New-York.
" " Vanuxem, Geol. Report Third District, p. 150. 1842.
" " Hall, Geol. Report Fourth District, p. 198. 1843.
Spirifera mucronata: Billings, Canadian Journal, May, 1861.

Shell more or less gibbous, semicircular, semioval, or triangular in outline; cardinal angles sometimes truncate but usually extended, and often extremely prolonged into mucronate points, giving a length of hinge-line two, three or four times as great as the shell; sides straight or curving, the front straight or concave.

Ventral valve often scarcely more convex than the dorsal, but in very gibbous forms becoming more unequal, gently curving to the lateral margins. The beak is small, and incurved over the narrow linear area, the mesial sinus is sharply defined quite to the apex, and limited by angular plications which are stronger than the adjacent ones. The

* *S. pseudolineata* and *S. setigera*, see Geology of Iowa, pp. 645 and 705.

prevailing form of the sinus is shallow and rounded in the bottom : it is sometimes flat and sometimes with a fold in the centre (See figure 11), and again it is angular (as in figures 19 and 20).

Dorsal valve moderately convex, sometimes becoming gibbous. The sides are gently curving, and usually flattened towards the cardinal margin : the mesial fold prominent and well defined, flat or rounded above, sometimes with a median groove and again angulated in the middle. The beak is incurved, and the area extremely narrow, about one-third as high as that of the ventral valve.

Surface marked by from eight or ten to twenty or more subangular plications on either side of the mesial fold and sinus : the plications are not very prominent but usually well defined, the outer half of the number not reaching the beak, but terminating in the callosity along the area-margin. The plications are crossed by numerous fine lamellose striæ, which become crowded together and closely imbricating towards the front of the shell, sometimes presenting several interrupted lines of growth.

The proportions are extremely variable, the length being in some specimens about two-thirds as great as the width ; while in others more extreme, the width is three inches or more, measured on the hinge-line, and the length is scarcely three-fourths of an inch. In one specimen before me, with a width rather more than four inches on the hinge-line, the length is less than three-fourths of an inch : this great lateral extension is not due to age. Some of the younger shells are extremely mucronate, as shown in figure 3; while in figures 1, 8, 10 and 11, showing gradations in size, there is comparatively little extension on the hinge-line.

The interior of the ventral valve shows short and rather strong teeth, with scarcely any extension of the dental plates, and a small striated muscular area, in the centre of which are the elongate occlusor muscular markings.

In the dorsal valve, the cardinal process or callosity is well preserved,

and the teeth-sockets are large, while the bases of the crura are often distinctly seen. The interior surface is usually papillose.

Geological formation and localities. This species begins its existence in the Marcellus shale (figure 3); and is abundant everywhere in the Hamilton group, sometimes constituting thin layers to the exclusion of every other fossil. In the eastern part of the State, in the arenaceous shales of this group, it occurs in the form of casts; and this is its usual condition in Schoharie, Otsego and Madison counties, while from Cayuga lake westward it retains the shell. In some places in Canada West it is found to be the prevailing fossil, while scarcely any other Spirifer occurs in the same association. I have received specimens of this shell, said to have been found near the Falls of the Maumee river. It occurs likewise in Maryland and Virginia.

In the Drift of Ohio, Indiana and Illinois, this species occurs more frequently perhaps than any other fossil.

The *Spirifera bimesialis* (Geol. Report of Iowa, page 507, plate 4, figure 6) is closely allied to *S. mucronata*, differing mainly in the much wider area and more elevated beak of the ventral valve. The *S. subattenuata* and *S. inutilis* of the same volume (pages 504 and 505, plate 4, figures 3 and 4) have similar external characters, with a shorter hinge-line and higher area than *S. bimesialis*. These two species are represented in form and proportions (except the extreme narrow area) by *S. mucronata*, Plate 33, figures 19, 20 and 21 of this volume.

Spirifera tullia (n. s.).

PLATE XXXV.

Shell gibbous, subelliptical; length and width about as two to three, or as three to four: hinge-line equalling or greater than the width of the shell; cardinal extremities truncate or auriculate.

Ventral valve gibbous, the greatest convexity above the middle of the shell, regularly arcuate from beak to base, curving abruptly to the sides and a little flattened at the cardinal extremities; beak strongly incurved: sinus sharply defined quite to the apex, not deep, rounded in the bottom. Area high, flat in the lower part and extending to the hinge-extremities, concave in the upper part.

DORSAL valve moderately convex; the mesial fold strongly defined, wide below and narrow above, flattened and sometimes depressed upon the summit; the lateral portions of the shell curving gently to the sides, with the cardinal extremities flattened.

SURFACE marked by from sixteen to eighteen comparatively wide flattened or low rounded ribs on each side of the fold and sinus; the exterior ribs fine and obscure. In exfoliated specimens, and sometimes in others, the ribs are subangular. The entire surface (including the mesial fold and sinus, and particularly the intervals between the plications) marked by fine continuous radiating striæ; while faint concentric striæ are visible on the fold and sinus, as well as obscurely on the costæ, and more decidedly upon the cardinal extremities; but these are subordinate to the radiating striæ.

The casts show the muscular area of the ventral valve to be elongate, and margined above by long dental plates which are comparatively strong as shown in figure 8. In another specimen, figure 9, there has been an elevated median crest in the muscular area.

The figures 1 and 6 of Plate 35 illustrate the prevailing character.

In general aspect this species resembles *S. medialis;* but it is more gibbous and proportionally less in width than the young of that shell, while the radiating striæ are a distinctive feature. The area also is more arcuate than in any forms of *S. medialis.*

It is with hesitation that I propose a new species of SPIRIFERA, while I am compelled to unite several that have hitherto been regarded as distinct; but in this one the characters seem to be distinguishing, and irreconcilable with any of the species heretofore described.

Geological formations and localities. In the shales of the Hamilton group, on the east side of Skaneateles lake, Owasco lake, Borodino, and in loose masses of the rock near Tully, Apulia and other places in Onondaga county. It is not at present known from more western localities.

Spirifera formosa.

PLATE XXVIII.

Spirifer formosa : Hall, Tenth Report on the State Cabinet, p. 154.

Shell semielliptical or subquadrate, more or less ventricose : valves about equally gibbous; hinge-line equal to the greatest width of the shell, with the extremities sometimes a little salient. Surface plicate.

Ventral valve most prominent above the middle and towards the umbo, with the sides regularly curving to the margin; the beak small, and neatly incurved over the area. Area rather high, continuing to the cardinal extremities, concave, and striated longitudinally; fissure large, wider than high : mesial sinus shallow, of moderate width, and sometimes with an obscure depression along the centre.

Dorsal valve regularly convex, a little flattened or sometimes concave towards the cardinal extremities : mesial fold but little elevated, flattened upon the summit, and sometimes a little depressed in the middle and continuing distinctly to the neatly incurved beak. Area distinct, of moderate height, and nearly parallel with the longitudinal axis of the shell.

The surface is marked by from fifteen to seventeen slender rounded plications on each side of the mesial fold and sinus; and these are crossed by fine concentric undulating striæ, which often become distinctly imbricate and stronger towards the margin. In well-preserved specimens, remains of extremely fine radiating striæ are found.

This is a neat symmetrical species, with a gracefully curved outline and salient angles. In profile, the beak of the ventral valve projects but little beyond that of the dorsal valve. The mesial fold, which is usually flat in the middle and lower part of the shell, is often distinctly grooved along the centre in the upper part, and this depression sometimes continues to the base.

Geological position and locality. In limestone of the age of the Hamilton group: Bake-oven, Illinois.

Spirifera sculptilis.

PLATE XXXV.

Delthyris sculptilis : HALL, Geol. Report of Fourth District New-York, p. 202. 1843.

SHELL gibbous; valves subequally convex, semielliptical or subtriangular: hinge-line longer than the width of the shell, and prolonged into mucronate extensions; length about half the width on the hinge-line. Surface coarsely plicated.

VENTRAL valve regularly convex, arcuate; beak arcuate over a sublinear area of moderate height, extending to the limits of the cardinal line; mesial sinus strongly defined, subangular.

DORSAL valve regularly convex, the greatest convexity in the middle and regularly arcuate from beak to base; mesial fold abruptly and strongly elevated, with the summit flattened or grooved; beak incurved : area very narrow.

SURFACE strongly marked by three, four or five abruptly elevated angular plications on each side of the mesial fold and sinus, leaving a somewhat wide corrugated space at the cardinal angles. The plications bordering the sinus are stronger, more elevated, and continuing distinct quite to the apex. The shell is concentrically marked by strong imbricating lamellose striæ, which are abruptly bent backwards and much elevated in crossing the plications, giving them a subnodose character. In the bottom of the sinus, these lamellose striæ have often a distinct retral bend, with a slight elevation indicating an incipient plication which corresponds with the depression in the mesial fold.

This species is readily recognized by its few strong plications, and the wide space at the cardinal extremities marked only by the concentric striæ. Comparatively few specimens have been found, and these are partially exfoliated.

In the figures illustrating this species, the dorsal valve is a cast.

Geological formations and localities. This shell, in its characteristic form, occurs in a calcareous layer in the Hamilton shales, at Eighteen-mile creek. It is found at Ludlowville in Cayuga county; on the east and west shores of Seneca lake, and at York in Livingston county.

Spirifera ziczac.

PLATE XXXV.

Delthyris zigzag : HALL, Geol. Report Fourth District, pp. 200 and 201. 1843.
Spirifer clio : HALL, in Thirteenth Report on the State Cabinet, p. 93. 1860.

SHELL transverse, gibbous or ventricose, semielliptical in outline, with the hinge-line equalling or greater than the width of the shell below; the cardinal extremities truncate or auriculate. Surface plicate.

VENTRAL valve the more convex, the greatest convexity being somewhat above the middle, arcuate from beak to front; sides regularly curving to the lateral margins: sinus deep and wide towards the front, rounded or flat in the bottom, produced in front, and sharply defined by the adjacent angular plications, which are stronger than the others; beak incurved. Area elevated, concave, with the margin angular and curving to the cardinal extremities.

DORSAL valve moderately convex at the sides; the mesial fold abruptly elevated, rapidly expanding below, flattened upon the summit, and usually marked by a mesial depression. The lateral portions of the shell curve towards the front, and are flattened or concave towards the cardinal extremities.

SURFACE plicated by about eight, ten, or even twelve strong angular costæ, those towards the cardinal extremities being less elevated and often obscure. The entire shell is marked by fine concentric striæ, which at intervals appear to be crowded together into stronger imbricating lamellæ, sharply arched and elevated upon the costæ and upon the mesial fold, and usually having a slight retral curve in the bottom of the sinus. In well preserved specimens, fine radiating striæ are visible.

The teeth are short and not very strong. The dental plates form a ridge along the margin of the fissure, and extend to the bottom of the cavity in its upper part, and margin the muscular area for only a short distance.

This shell resembles *S. sculptilis;* but it is more gibbous and has a larger number of plications, extending quite to the auriculate cardinal extremities; the sinus is also wider and the front more elevated. Usually only the coarse lamellæ are conspicuous upon the surface, the finer striæ being obscure or covered by adhering matter.

Figures 13 and 14 of Plate xxxv offer characters which are apparently intermediate, having coarser lamellæ than the original specimens of *Spirifera zigzag;* and it was from specimens of similar form that I described *S. clio.*

This species varies in dimensions from half an inch to an inch and a quarter in width, with a length two-thirds to three-fourths as great.

Geological formations and localities. In the Hamilton group, at Moscow, York, Geneseo, Darien, and Eighteen-mile creek, and less frequently on Seneca and Cayuga lakes.

Spirifera granulifera.

PLATES XXXVI & XXXVII.

Delthyris granulifera : HALL, Geol. Report Fourth District New-York, pp. 206 & 207, f 1. 1843.
" *congesta* : ID. Ib. f. 2.
Spirifer heteroclitus : MARCOU's Explanatory Text, etc. Pl. 8, f. 7.
" *granulifera* : HALL, Tenth Report on State Cabinet, p. 163.
Compare *S. clintoni*, ID. Ib. p. 157.
" *S. duplicata*, CONRAD, Jour. Ac. Sciences, Philadelphia, Vol. viii, pa. 261, pl. 14, f. 16.
" *S. arcta* : HALL, Tenth Report on the State Cabinet, p. 161.

SHELL semicircular, semielliptical or subcircular, ventricose, often becoming gibbous; hinge-line generally equal to the greatest width of the shell; cardinal extremities obtuse, or sometimes rounded, rarely extended : valves subequally convex; surface plicate.

VENTRAL valve less ventricose than the dorsal, most prominent near the umbo, gradually sloping to the cardinal extremities; beak moderately elevated, somewhat pointed and incurved. Area of moderate height, divided in the centre by a rather large triangular foramen which is about as high as wide. Mesial sinus distinct and subangular in the upper part, becoming a broad deep rounded depression in front, and often having a slight groove along the centre, with sometimes an indication of one or two small faintly-marked plications just within the margins.

Dorsal valve generally the most ventricose, the greatest convexity a little above the middle, curving abruptly to the sides, and often a little depressed just within and below the cardinal angles, which are there slightly inflected. Mesial fold very prominent, rounded, and marked along the middle by a distinct rounded depression which is sometimes very deep, though in rare examples it is represented by only a flattening of the fold : beak rather prominent and well marked. Area somewhat large, extending to the extremities of the hinge-line.

Surface marked by about twenty or twenty-two simple low rounded plications on each side of the mesial fold and sinus, often becoming quite flattened near the front margin of old or full-grown individuals. The entire surface of the plications, fold and sinus, is covered by extremely fine interrupted longitudinal striæ, which form numerous minute pustules or short slender spines, giving a strongly granulose aspect to the shell. The striæ are seen only on extremely well preserved surfaces; while the granulose character is a common feature, except on exfoliated or worn specimens. Numerous concentric lines of growth and finer concentric striæ cross the plications, and often become crowded near the front margin of adult specimens.

Interior of the ventral valve with a broad and somewhat quadrangular muscular impression, which varies much in size in different individuals, and is often marked in the upper part with strong transversely radiating striæ, and in the lower part with longitudinal striæ. The upper part of the impression is bounded by strong dental lamellæ, which unite with the broad teeth above. The upper part of the valve is thickened, the shelly matter often filling the rostral cavity, and extending as a transverse septum in the bottom of the fissure for one-third or one-half its length. In the interior of the dorsal valve, the muscular impressions are often well defined, with a faintly marked mesial septum through the centre.

This species is subject to considerable variation; some specimens being but moderately convex, and others extremely ventricose. In some the mesial fold is scarcely flattened, while in others the central groove is nearly half the depth of the fold. There is also much difference in the height of the area and in the incurving fo the beak; while in some individuals the cardinal angles are extended considerably beyond the sides of the shell, and in others they are shorter and rounded.

Spirifer congesta (Geol. 4th District) is a specimen of this species having a short hinge-line and very obtuse cardinal extremities, a narrow area, incurved beak, and a mesial fold simply flattened instead of the usual groove; while the granulose character of surface is scarcely perceptible. *Spirifer clintoni* (10th Rep. on State Cabinet) was founded upon small specimens of this species occurring in a band of limestone, and having the granulose surface entirely removed by exfoliation, while the plications and sinus have a sharper and more angular expression, and the cardinal extremities are more extended than usual (See Plate XXXVII).

The specimens figured on Plate XXXVI illustrate the prevailing forms observed in the calcareous shales of the Hamilton group in Western New-York. Smaller specimens than figure 1 are extremely rare, while it is not often observed of greater dimensions than fig. 10. The elevation of the beak of the ventral valve as shown in figures 3 and 7 is the prevailing character; though in specimens like fig. 6 (*S. congesta*, ut cit.), the umbo of the dorsal valve is much more elevated, while the beak of the ventral valve is less extended. The interior characters of the dorsal and ventral valves of well-formed and full-grown individuals are shown in figures 11 & 12. Some casts of this and allied forms are figured on Plate XXXVIII A.

Geological formation and localities. This species is known in the Hamilton group in Schoharie, Otsego and Madison counties, usually in the condition of casts. It is coextensive with the Hamilton group in the State of New-York, occurring on the shores of Cayuga, Seneca and Canandaigua lakes; at Geneseo, Moscow and York in Livingston county; at Pavilion and Darien, Genesee county, and at Eighteen-mile creek in Erie county, as well as numerous other places. The variety with more angular extremities and mesial fold, which I have designated as *S. clintoni*, is known only in a calcareous band at Eighteen-mile creek. The species likewise occurs in Pennsylvania, Maryland and Virginia.

SPIRIFERA GRANULIFERA

Spirifera marcyi.

PLATE XXXVII.

Spirifer marcyi : HALL, Tenth Report on State Cabinet, p. 158.

SHELL semicircular or subelliptical in outline, gibbous or moderately convex; cardinal extremities extended, sometimes submucronate: valves subequally convex. Area variable in height. Surface plicated.

VENTRAL valve scarcely deeper than the opposite, except in young individuals; very regularly arcuate, with sides sloping somewhat gradually from the beak to the cardinal extremities : beak usually prominent and pointed, sometimes incurved. Area variable in height, more or less incurved, often nearly flat, strongly striated longitudinally, the inner portion finely marked by vertical striæ; fissure higher than wide, one-third or more of the upper part closed by a strong transverse plate or septum. Mesial sinus distinct but not deep, rounded or flattened in the bottom, with subangular margins in the upper part which become more rounded near the front.

DORSAL valve varying from moderately convex to gibbous, a little flattened near the cardinal extremities in some specimens. Mesial fold not very prominent, rounded on the top, distinctly defined at the margins. Area of moderate width.

SURFACE marked by from twenty-four to thirty simple rounded plications, which are little elevated and of moderate strength, crossed by fine concentric lines, and marked (in some of the larger specimens) by a fine longitudinal groove along the middle, or otherwise longitudinally striated : this is not a constant feature. In both valves the surface is marked by very fine elongate pustules, which become crowded towards the front in old individuals. This gives a very marked and reliable character when preserved as shown in fig. 18, Plate XXXVII.

The species presents considerable variations in height of area in the ventral valve, which in some specimens is large with an arched beak, and in others narrow with the beak much incurved : in the latter variety, the valve is more gibbous. In the original specimens described, the area is nearly flat, with its exterior margin sharply defined and the beak little incurved. The shells vary also in the gibbosity of the valves, in the extension of the cardinal extremities, and somewhat in the strength of the plications.

The figures 10 – 16 illustrate the prevailing form and characters of this species.
Fig. 17 is of the interior of the dorsal valve : the interior of the ventral valve is unknown.
Fig. 18 is an enlargement of the surface.

Geological formation and localities. The original specimens described were from the Hamilton group at Covington in Genesee county. It has since been found among collections from the shores of Cayuga and Seneca lakes; at Dresden in Yates county; on the shore of Canandaigua lake, and at Geneseo and York in Livingston county.

Spirifera medialis.

PLATE XXXVIII.

Delthyris medialis : Hall, Geol. Report Fourth District New-York, p. 208, f. 8. 1843.
Spirifer medialis : Hall, Tenth Report on State Cabinet, p. 164.
Compare *Delthyris audacula*, Conrad, Jour. Acad. Nat. Sciences, Philadelphia, Vol. viii, p. 262.

Shell subtriangular, semicircular or subelliptical : valves moderately convex in young specimens, becoming ventricose in old shells; hinge-line usually extended beyond the width of the shell below, sometimes mucronate at the extremities : surface plicate.

Ventral valve usually deeper than the dorsal : beak prominent, more or less incurved. Area generally of more than medium height, longitudinally striate and divided in the middle by the deltoid fissure, which is twice as high as wide, and reaches to near the apex of the valve. Mesial sinus of moderate width, reaching to the apex, rather deep, generally rounded at the bottom, but sometimes a little flattened; the margins subangular and distinct.

Dorsal valve moderately convex or gibbous, the greatest convexity above the middle : beak small and slightly incurved. Area linear and well defined; the lateral extremities of the valve a little deflected along the hinge-line. Mesial fold prominent, rising abruptly at the sides, rounded or slightly flattened on the top.

Surface marked by from twenty to thirty simple plications on each side of the mesial fold and sinus. These are of medium size in full-grown shells, being either low rounded, flattened, sharply rounded, or subangular in different individuals; the principal ones are frequently marked along the centre by a fine threadlike groove, a feature most

common on the ventral valve. Numerous strong concentric lines of growth mark the surface, and are very closely arranged near the front in full-grown specimens, giving a strongly imbricate character to that part of the shell.

Interior of the ventral valve marked by a somewhat quadrangular medium sized muscular impression, which is bordered in the upper part by strong dental lamellæ : teeth prominent, of moderate strength. The fissure is usually partially or entirely covered by a pseudo-deltidium, and the upper part of the rostral cavity is often filled and solid, with a strong plate or septum closing the bottom of the fissure for one-third or one-half its length. In a single individual, the deltidial covering was observed to be composed of successive arching and imbricating plates, which, in the lower part, apparently consist of a double alternating series. The muscular impressions of the dorsal valve are less strong than those of the ventral, but often well marked, with a distinct median ridge; teeth-sockets projecting into the cavity of the valve; lateral portions of both valves strongly marked by the plications.

Spirifera medialis.

This shell is subject to many and extreme variations in the extent of hinge-line, convexity of the valves, height of area, and incurving of the beak : the plications also vary in number and strength. It is an abundant form, coming next in number of individuals to the *S. mucronata*. The following species, described by me in the Tenth Report on the State Cabinet, is probably only a variety of this species with fewer and stronger ribs. In its ordinary or prevailing form and features, it is a species readily recognized : it is only since larger collections have been examined from numerous and widely-separated localities, that these extreme variations have been observed.

Geological formation and localities. This species is found in casts in the coarser shales of Otsego and Madison counties, and becomes common on the shores of Cayuga and Seneca lakes and on the outlet of Crooked lake. It is found on the

shore of Canandaigua lake, and at Geneseo, Moscow and York in Livingston county; at Covington and Darien in Genesee county, and at Eighteen-mile creek in Erie county. It is extremely rare, if occurring at all, in more western localities.

Spirifera medialis, var. eatoni.

PLATE XXXVIII.

Spirifer eatoni : HALL, Tenth Report on State Cabinet, p. 157.

SHELL robust, semicircular or subelliptical, extremely ventricose; hinge-line equalling or less than the width of the shell below : valves subequally convex : surface plicate.

VENTRAL valve much elevated in the umbonal region, sloping gradually to the cardinal extremities, which are either obtusely pointed or rounded. Mesial sinus moderately wide, not deep, flattened on the bottom, angular at the sides, and reaching to the beak. Area high, straight or but little incurved, with a narrow deltoid opening reaching to or near the apex of the valve : beak small, pointed, slightly incurved.

DORSAL valve convex, a little flattened or slightly inflected near the cardinal extremities : mesial fold well marked, rising abruptly at the sides and flattened on the top. Area narrow linear.

SURFACE marked by from fifteen to eighteen simple rounded plications on each side of the fold and sinus, with sharply defined narrow spaces between, and crossed below the middle by strong imbricating lines of growth.

Interior of the shell unknown.

There is probably no sufficient reason for retaining this variety as a species, and perhaps a large number of individuals will show an insensible gradation from the typical forms of *S. medialis* to the more robust and ventricose forms with short hinge-line and fewer plications.

Geological formation and localities. In the Hamilton group, on the shore of Seneca lake; at York in Livingston county, and probably at other places.

Spirifera angusta.

PLATE XXXVIII A.

Spirifer angusta : HALL, Tenth Report on State Cabinet, p. 164.

SHELL very depressed pyramidal, extremely extended transversely; cardinal extremities attenuate, acuminate: valves very unequally convex, with surface finely plicate.

VENTRAL valve proportionally very deep, forming nearly the entire thickness of the shell : beak elevated and pointed, or slightly incurved at the apex; the cardinal margins sloping very regularly to the hinge-extremities. Area extremely elevated and inclined forward; the full height equal to the length from the beak to the front of the valve; longitudinally and vertically striate, divided in the middle by a foramen which is but little more than half as wide as high, and distinctly grooved on the sides for the reception of the deltidial plate.

DORSAL valve very depressed-convex, with a narrow and low mesial fold which is somewhat flattened at top : beak small but distinct, projecting but little beyond the line of the hinge. Area extremely narrow, and nearly rectangular to the area of the ventral valve.

SURFACE marked by about twenty-four to twenty-eight fine simple rounded plications on each side, few of which reach to the beak. The plications are crossed by very fine concentric rugose striæ, which are slightly arched upwards on the plications and on the mesial fold.

Interior of the valves unknown.

This species is usually readily distinguished by its extreme lateral extension, and by the elevated and more or less receding area, which is usually nearly as high or higher than the length of the ventral valve. There is frequently a slight incurvation at the apex of the ventral valve, and sometimes the area is nearly vertical. In this condition it approaches in general form to the young of *S. medialis*, which has always a proportionally longer ventral valve.

The specimens of this species have usually a length of an inch or an inch and a quarter (as in the accompanying figure); while the largest individual observed is that figured on Plate XXXVIII A, which has a width of more than two inches.

SPIRIFERA ANGUSTA.

This species may be compared with *S. segmenta* of the Corniferous limestone; but I have not been able to identify the two as a single species.

Geological formation and localities. This species occurs in the Hamilton group at Geneseo and York in Livingston county, and at Covington in Genesee county.

Spirifera macronota.

PLATE XXXVIII A.

Delthyris macronota : HALL, Geol. Report Fourth District New-York, p. 206, f. 5. 1843.
Spirifer macronotus : HALL in Catalogue in Report on State Cabinet. 1859.

SHELL transverse, subtriangular or broadly semielliptical; hinge-line much extended, extremities often mucronate: valves unequal in depth; area large; surface plicate.

VENTRAL valve elevated at the beak, abruptly sloping to the front and lateral margins, with but little convexity: slope of the cardinal border very regular to near the extremities. Area one-third as high as long; more usually straight or very slightly arcuate, and longitudinally striate : fissure about twice as high as wide, reaching to the apex of the valve; beak minute. Mesial sinus rapidly widening, shallow, flattened at bottom, with margins subangular especially in the upper part.

DORSAL valve varying from depressed-convex to gibbous, most convex above the middle; lateral extremities often inflected; beak incurved, not prominent: area linear. Mesial fold well marked, usually flattened on the top, sometimes strongly rounded.

SURFACE marked by from twenty-five to thirty-five slender simple radiating plications on each side of the fold and sinus; these are either flattened or rounded : three or four only on each side reach to the beak, while the remainder are lost on the margins of the area. The valves are crossed by numerous strong concentric imbricating lines of

growth, which give an irregular margin to the area, and are often crowded near the front of the shell, causing an abrupt truncation of the extremities of the ventral area.

Interior of the ventral valve with comparatively small but well-marked muscular impressions; that of the dorsal valve not satisfactorily determined. The margins of the interiors of the valves are usually crenulated by the plications and the stronger concentric lamellæ of growth. The fissure is sometimes partially covered by a pseudo-deltidium, and closed by a solid septum for one-third of its length from the apex.

The characteristic features and expression of the fossil are shown in the accompanying woodcut.

Spirifera macronota.

Geological formation and localities. This species occurs on the shore of Seneca lake; at Bristol, Ontario county; at Geneseo and Moscow in Livingston county; at Darien, Genesee county, and at Hamburgh and Eighteen-mile creek in Erie county.

The three preceding species (*Spirifera medialis*, *S. angusta* and *S. macronota*), in what may be termed typical specimens, are so clearly distinguishable one from the other, that we have no difficulty in designating them. It is only in large collections of specimens that we find individuals which are not readily referable to either of them. The young of *S. medialis* are often much extended at the cardinal extremities; and though generally distinguishable from the young of *S. macronota* by the lower and more arcuate area, yet there are gradations which often seem to unite the two. A similar difficulty occurs when we attempt to separate *S. angusta* from the young of *S. macronota;* and there are numerous individuals, not always, it is true, in a perfect state of preservation, which it is nearly or quite impossible to refer with satisfaction to either of the species.

Add to this resemblance in general form, proportions of area, etc., the great similarity of surface characters, and the question seems scarcely to admit of a solution without uniting all these as one species.

Regarding *S. angusta* as the young condition, we need only a less development and arcuation of the area, with coarser plications, to make it undistinguishable from a young *S. medialis*. Carrying on the development in the same direction, shortening the cardinal extremities and increasing the gibbosity of the valves, we have the *S. medialis* in its typical form. Going still farther in the same direction, the cardinal extremities may become rounded, the valves ventricose, and the area arcuate, with still stronger plications, giving the var. *eatoni*.

In the younger forms we have those with the area slightly arcuate, vertical and receding. If we regard these features as only conditions of the same species, we may have those with the vertical areas developed in the same direction, while the cardinal extremities continue much extended, until we have the typical form of *S. macronota*. These forms continuing, the area vertical or slightly inclined but scarcely arcuate, may have the cardinal extremities shortened and the shell becoming ventricose, presenting form and characters which it is equally difficult to refer to either *S. medialis* or *S. macronota*. Again, we find here and there, among the collections of Hamilton Spirifers, a form where the area is vertical as in *S. macronota*, but the lateral extensions much less, and the ribs fewer and perhaps a little stronger, suggesting a relation to *S. euruteines* and *S. manni* of the Corniferous limestone.

I am not at present prepared to assert the identity of all these forms; but I can easily believe that larger and more extended collections, made over geographical areas not yet explored, may show a much closer relation than we have supposed to exist between them.

I have endeavored, in Plates XXXVIII and XXXVIII A, to show all the important varieties of form, selected from a collection of several hundred individuals, and in which the specimens readily referable to *S. medialis* are at least ten times as numerous as those which can be referred to either of the other species.

Spirifera acuminata.

PLATE XXXV : FIG. 24.

Spirifer acuminatus : CONRAD, See page 198 of this volume.
Delthyris prora : CONRAD, Jour. Acad. Nat. Sciences Philadelphia, Vol. viii, p. 263.

"UPPER valve trigonal, profoundly ventricose; ribs double, not very "prominent, eighteen or twenty in number; mesial fold profoundly "prominent and acutely angular; hinge-line shorter than the width "of the shell : length one inch and five-eighths; width two and a "half inches."

The only species in the Hamilton group corresponding with Mr. CONRAD'S description, is one which I have identified with *S. acuminata;* the dorsal valve of this is shown in figure 24, Plate XXXV. The ribs are more conspicuously bifurcating than in those from the limestone, and the muscular impression is larger; but both these features are variable, and therefore cannot be relied upon for specific distinction.

The localities in the Hamilton group have been cited on page 202.

Spirifera subumbona.

PLATE XXXII.

Orthis subumbona : HALL. Tenth Report on the State Cabinet, p. 168. 1857.
Ambocælia subumbona : ID. Thirteenth Report on the same, p. 71. 1860.

SHELL small, more or less gibbous or ventricose; cardinal extremities rounded : surface smooth, or finely striated concentrically.

VENTRAL valve ventricose in the middle, regularly curving towards the basal and lateral margins : umbo much elevated above the opposite valve, and beak abruptly incurved over the high area, which has its lateral margins rounded or rarely defined, and sloping towards but not reaching the cardinal extremities; more or less arcuate, and the elevation apparently variable. The foramen is higher than wide, and open to the apex in all the specimens observed. There is usually a narrow but not always distinct mesial sinus, reaching from the apex to the base of the valve, where it becomes wider but without defined limits.

Dorsal valve less gibbous than the ventral, somewhat regularly convex in the middle, and curving towards the front and baso-lateral margins; a little depressed or flattened towards the abruptly rounded cardinal extremities : umbo slightly elevated above the hinge-line ; area linear. There is often a faint impressed line extending from the beak to the base of the valve.

Surface marked by fine concentric lines of growth, which are sometimes crowded into imbricating folds towards the front of the shell. In partially exfoliated specimens the surface is finely and distinctly punctated, as if in its original condition it had been covered by closely arranged spinules. The texture of the shell is fibrous, but yet differing from the fibrous texture of ordinary Spirifers.

This species is a miniature of the *S. lineata* of the Upper Carboniferous beds, having the same general aspect and characters of surface marking : it is, however, usually a little more extended laterally, and the area continues more nearly to the cardinal extremities. The punctate markings are comparatively finer, and it has not the regular concentric undulations which often mark the carboniferous species. It has likewise a distinct impressed line or narrow sinus in the dorsal valve.

The ventral valve alone has much the appearance of Ambocœlia, and I had thus referred the species from some crushed and imperfect specimens. Farther examinations have brought out specimens in their true form and proportions; not only from the calcareous beds near the base of the Hamilton group, but also from the Tully limestone we have specimens undistinguishable from this one.

Geological formation and localities. In the calcareous bands of the Hamilton shales, on the shore of Lake Erie; in the Tully limestone near Tully, and from the same rock in Seneca county.

Spirifera arata.

Spirifer arata : Hall, Tenth Report on the State Cabinet, p. 161. 1857.

I have already referred to this species under *S. granulifera*. The original specimens designated as *S. arata*, upon re-examination, do not offer satisfactory means for separation from *S. granulifera ;* and therefore it becomes unnecessary to continue the name.

Spirifera duplicata.

Delthyris duplicata : Conrad, Jour. Acad. Nat. Sciences Philadelphia, Vol. viii, pa. 261. pl. 14, f. 16.
" " : Id. Ib., referred to under *S. granulifera*, page 223 of this volume.

Since the preceding pages were sent to the press, I have observed, among some specimens from the coarser shales of the Hamilton group, the cast of a Spirifer with duplicate mesial fold and angulated ribs, corresponding to the original description of *S. duplicata*. The material at hand is not sufficient to determine its specific value.

Spirifera corticosa.

Spirifer corticosa : Hall, Tenth Report on the State Cabinet, p. 160. 1857.

Of this species, I have not obtained sufficient material to satisfy me of its claim to specific distinction. A well-marked ventral valve, which I have referred to this species, still remains unidentified with any other species; while two other well-marked individuals*, originally referred to the same, prove to be quite distinct from this and every other species; so that in the present state of knowledge, I propose to leave the specimens without illustration, and subject to future revision.

Spirifera tenuis.

Spirifer tenuis : Hall, Tenth Report on the State Cabinet, p. 162. 1857.

The specimens on which this species was originally founded are silicified in whole or in part, and it is impossible to know satisfactorily what effect the silicification and partial solution of the shell may have had in removing or modifying surface characters. This species is therefore left undetermined for the present.

Spirifera pertenuis.

Spirifer pertenuis : Hall, Tenth Report on the State Cabinet, p. 163. 1857.

The specimens of this species are in a condition similar to the last, and are consequently left for farther study.

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* These are probably not from the Hamilton group, though given to me as authentic.

SPIRIFERÆ OF THE PORTAGE AND CHEMUNG GROUPS.

The shales and sandstones of the Portage group, within the limits of the State of New-York, are generally very deficient in Brachiopoda, and but a single species of Spirifer is at present known to me in this formation. This one is more like the European Carboniferous *Spirifera glabra*, than any of the Devonian species figured by Mr. Davidson in his Monograph of British Devonian Brachiopoda.

In the Chemung group, Brachiopoda are abundant, and Spirifera is very conspicuous among the other genera. Notwithstanding however its abundance and wide distribution in this group, there are few species known in the State, and of these, one only is common, the *Spirifera verneuili* = *S. disjuncta* and its varieties, which extends from the southeastern counties quite to the western limits of the State, and is equally abundant in the adjacent portions of Pennsylvania along the southern and western borders of New-York.

I have heretofore recognized, with doubt, the *Spirifer mucronata** in the Chemung group in the southern part of New-York; but a critical examination of all the specimens from authentic localities of that formation has shown that the fossils thus referred belong to the *S. mesacostalis*, and no true example of *S. mucronata* is yet known to me from the Chemung group.

It may be remarked in this place that the shaly sandstones or arenaceous shales of the Hamilton group in the southeastern part of the State are lithologically similar to some of the Chemung beds, and not always readily distinguishable therefrom. In these coarser beds of the Hamilton group, the *S. mucronata* is often abundant in the condition of casts.

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* *Delthyris mucronata?* Geological Report of the Fourth District of New-York, p. 271.

In the upper part of the Chemung group, and sometimes apparently near the summit of the formation, there is a grayish or ferruginous conglomerate, often charged with fossil shells, among which there are usually few Brachiopoda; and in some localities the general aspect of the fauna is more nearly like that of the Waverly sandstone of Ohio, some of the species being apparently identical with those of that formation and the western extension of the same. I have, however, detected in this conglomerate casts of *Spirifera mesacostalis* and *S. verneuili* = *S. disjuncta*, as well as other forms which show its intimate relation with the Chemung group.

These are the beds which I have heretofore indicated as those which may become expanded in their western extension, and constitute in part the fossiliferous sandstones and shales of Eastern Ohio; while the Portage and Lower Chemung beds, which do physically extend into that part of Ohio, are less fossiliferous than in New-York, and their presence has been overlooked by some observers. At the same time, there is a disposition not only to claim for the higher portions a distinct place in the series, but to refer these beds to a distinct system. By whatever name, however, they may be termed, they apparently constitute part of the great group of argillaceous and arenaceous shales and sandstones which began their deposition with the Marcellus shale, and terminate with the red shales and sandstones of Pennsylvania, or at the base of the conglomerate of the Coal measures, as that formation exists on the borders of southern New-York and the adjacent counties on the south and west*.

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* I had intended, before the completion of the volume upon the Brachiopoda, to have made personal investigations to determine more accurately the relations of these formations; but have been for two years prevented from accomplishing any field work of importance.

Spirifera lævis.

PLATE XXXIX.

Delthyris lævis : HALL, Geol. Report Fourth District New-York, p. 345, f. 1. 1843.

SHELL ventricose, subcircular or semielliptical, with the cardinal extremities rounded : length and breadth as two to three, or three to four; not plicate.

VENTRAL valve subventricose; the greatest convexity above the middle, from whence it curves gently to the base and suddenly towards the beak, which is abruptly attenuate and arching over the area : sinus variable, often shallow, gently concave and scarcely defined; sometimes becoming deep, subangular, and very broad in the lower part. Area extending to the hinge-extremities, of moderate height at the sides and rising abruptly towards the middle; foramen partially closed by an arching, very convex pseudo-deltidium.

DORSAL valve depressed or moderately convex, with a wide and usually undefined mesial fold which is much expanded below, leaving the anterior margin sinuate : sides of the shell somewhat regularly curving, and a little flattened at the cardinal extremities.

SURFACE usually smooth, or marked only by concentric lines of growth. In older shells there are sometimes a few obscure and undefined radiating folds.

The interior of the ventral valve shows strong short teeth with the dental lamellæ much thickened, filling up the rostral cavity and extending along the sides of the upper part of the muscular impression : the muscular space is small or of moderate size, deeply marked, and often preserving a distinct median crest.

In the dorsal valve the muscular impression is small and narrow, and usually not deeply marked. The cardinal process is strongly striated, and this character is distinctly preserved in the cast.

This species, though occurring in considerable numbers at one locality and less commonly in another, has nevertheless been seen only as imperfect or distorted

specimens, or in the condition of casts. All the specimens which have the two valves attached are more or less crushed, as shown in figure 3.

The specimens figured illustrate the usual condition of the species.

Figures 1 & 2 are casts of a dorsal and a ventral valve of small size.
Figure 3 is a dorsal view of a specimen having the shell crushed.
Figure 4 is a cast of a large dorsal valve.
Figures 5 & 6 show the area and interior of the ventral valve.
Figure 7 is the exterior of a large ventral valve preserving the shell, and showing a remarkably wide subangular sinus, with obscure plications on the sides of the shell.
Figures 8 – 11 show the characters of the muscular impression.

Geological formation and localities. In the shale of the Portage group, near Ithaca; and in a shaly sandstone of the same age, near Cortlandville, Cortland county, New-York.

Spirifera mesacostalis.

PLATE XL.

Delthyris mesacostalis : Hall, Report of the Fourth Geol. District, p. 269, f. 9. 1843.
Delthyris acuminata : Id. Ib. p. 270, f. 5.
Not *Delthyris acuminata*, Conrad, cited on page 198 of this volume.

Shell variable in form, more or less gibbous, semioval or subquadrate; cardinal extremities usually a little salient : surface plicated. The width varies from once and a half to three times the length.

Ventral valve ranging from semielliptical and moderately convex, to subquadrate and ventricose. In the less gibbous and more extended forms the convexity is pretty regular in the upper part of the shell, curving more abruptly towards the front, and nearly flat towards the cardinal extremities. The beak is small, and the upper part only abruptly incurved over the area, which is of moderate height : the sinus is angular, varying in depth, and marked by a single defined fold in the bottom, which is usually distinctly angular, but rarely rounded or depressed. The fissure is higher than wide, and usually not closed by a pseudo-deltidium.

Dorsal valve very gibbous in the middle and pretty regularly convex from beak to base, depressed towards the cardinal extremities, and

becoming quite flat in the more extended forms : mesial fold usually strongly defined, rising abruptly above the surface on either side, and marked along the centre by a deep groove. The area is narrow-linear.

Surface marked by from ten to fourteen rounded or subangular plications, those on either side of the mesial fold and sinus being usually stronger than the others. When the shell is fully preserved, and sometimes in partial casts, the surface is marked by strongly arching lamellose striæ or lines of growth, which become much crowded towards the margin of the valves.

Little is known of the interior structure of this species. A cast of the ventral valve shows extended and not greasly divergent dental lamellæ, with a strong longitudinal median crest or septum in the muscular impression.

The specimens under examination are nearly all in the condition of partial casts, or with the shell more or less exfoliated; while all are in single valves, adhering to the sandstone or shale in which they are imbedded.

The species is well marked and quite distinct from any other in this formation, though showing a wider range of variation in forms and proportions than I had originally supposed. The short forms with extremely extended and mucronate cardinal extremities, which are figured in the Report of the Fourth District, p. 270, f. 5 & 5 *a*, prove, by several gradations of form, to be of the same species. This variety resembles the *Spirifera mucronata*, for which it has no doubt sometimes been mistaken.

Among specimens from Ithaca (N.York), there are numerous small individuals of this species, which, on a cursory examination, might be regarded as the young of *S. mucronata*. The specimens are for the most part casts, and the dorsal valve shows the duplication of the mesial fold; but there is no (or scarcely any) indication of the plication in the bottom of the sinus, although there is unmistakable evidence of a longitudinal septum extending from the beak to near the base of the muscular impression, a feature not known to exist in *S. mucronata*. The specimens are usually semielliptical and little extended on the hinge-line, but in some individuals there is a great extension of the cardinal extremities. From these small individuals there is an almost insensible gradation to the larger forms, as shown in the illustrations on Plate XL. In the laterally extended forms the area is low, while in the shorter and more rotund forms it is more elevated, as shown in the figures. The more gibbous forms have been found in a compact sandstone on the Genesee river, while the smaller and attenuated ones are from more easterly

localities. The species has been collected in the shaly beds in the higher part of the group near the southern limits of Steuben county, and it occurs in a coarse sandstone and conglomerate in the upper part of the formation near Olean in Allegany county.

Geological formation and localities. In the Chemung group at Ithaca, and at Bald hill south of Ithaca, Tompkins county; at Philipsburgh near Angelica, and at Rockville in Allegany county; near Paintedpost on the Chemung river; at Troupsburgh in Steuben county, near Olean in Allegany county, and at Randolph in Cattaraugus county.

Spirifera mesastrialis.

PLATE XL.

Delthyris mesastrialis: Hall. Geol. Report Fourth District, p. 269, f. 1. 1843.

Shell large, semielliptical, more or less gibbous, with the cardinal angles rounded or produced into mucronate extensions : surface plicated.

Ventral valve variable in its convexity, being gibbous or subventricose in the upper part, curving gently to the front and baso-lateral margins, while it is depressed or nearly flat towards the cardinal extremities. Beak incurved over the area, which is of medium height and continued to the cardinal extremities : mesial sinus rapidly expanding and becoming very wide below, in some specimens being of moderate depth and in others very deep, and rounded in the bottom, with the margins well defined.

Dorsal valve more or less gibbous, often with a very regular convexity when the cardinal extremities are not extended. In other examples the central portion is somewhat regularly convex, and depressed or flattened towards the extremities, which may be rounded, slightly auriculate, or prolonged into mucronate points. The mesial fold becomes rapidly expanded in its lower part, with the summit broadly rounded.

Surface plicate with about sixteen to twenty rounded ribs, which are sometimes low and nearly flat, or become more strongly elevated in some of the larger individuals. There are usually from eight to twelve ribs on each side, which are conspicuous, while the remainder are attenuate and obscure. The plications, together with the mesial fold and

sinus, are conspicuously marked by fine regular radiating striæ, and, in rare examples, these have been observed to be cancellated by concentric striæ.

Little is known of the interior of the shell, beyond the presence of strong teeth and straight diverging dental lamellæ.

The species presents considerable variety in its form and proportions; but there is usually little difficulty in distinguishing it by the external characters, from any other species in this formation. In its more rotund forms, it approaches the *S. granulifera;* but the presence of longitudinal striæ may usually be recognized in the casts, while the broad rounded mesial fold without a depression, is a distinguishing feature.

Geological formation and localities. This species has been found in Schoharie and Delaware counties (New-York), several hundred feet above the base of the Chemung group. Fine robust specimens occur near Cortlandville in Cortland county, and a more delicate variety in the greenish shales north of Elmira. The stronger forms, with extended cardinal angles, occur on Cayuta creek in Tioga county.

Spirifera disjuncta.

PLATES XLI & XLII.

Spirifera disjuncta : Sowerby, Trans. Geol. Society, 2d series, Vol. v, pl. 53, f. 8; pl. 54, f. 12, 13. 1840.
" *calcarata :* Id. Ib., pl. 53, f. 7.
" *extensa :* Id. Ib., pl. 54, f. 11.
" *gigantea :* Id. Ib., pl. 55, f. 1 – 4.
" *inornata :* Id. Ib., pl. 53, f. 9.
" *protensa :* Phillips, Pal. Foss. of Cornwall, Devon & West-Somerset, pa. 69, pl. 28, f. 118. [1841.
" *calcarata* & *S. disjuncta :* Id. Ib., pl. 29, f. 128, 129.
" *disjuncta :* Id. Ib., pl. 30, f. 129.
" *gigantea :* Id. Ib., pl. 30, f. 130.
" *grandæva :* Id. Ib., pl. 30, f. 131.
" *distans :* Phillips (not Sowerby), Ib., pl. 29, f. 127.
" *verneuili :* Murchison, Bull. Soc. Geol. France, Vol. 11, pa. 252, pl. 2, f. 3. 1840.
" *archiaci :* Id. Ib., pl. 2, f. 4.
" *lonsdalei :* Id. Ib., pl. 2, f. 2. [1845.
Spirifer disjunctus : Murchison, De Verneuil and Keyserling, Geol. Russia, Vol. 2, pa. 157, pl 4, f. 4.
" *archiaci :* Id. Ib., pl. 4, f. 5. 1845. [1845.
" *murchisonianus* :* De Koninck, De Verneuil & Keyserling, Geol. Russia, Vol. 2, pl. 4, f. 1.

* I have cited the synonymy to a great extent from Mr. Davidson's British Devonian Brachiopoda, where the *Spirifera murchisoniana* (De Koninck) is given as one of the synonyms of *S. disjuncta.* I have not observed the explanation which allows this species to be a synonym of *S. disjuncta,* and at the same time a Cyrtia, Cyrtina (Davidson, Quarterly Geological Journal, Vol. ix, pa. 355, pl. 15, f. 6 – 9); but it appears to me that the species figured in the Geology of Russia is distinct from the Chinese specimens figured by Mr. Davidson.

Spirifer disjunctus : Davidson, Quar. Jour. Geol. Society, Vol. 9, pa. 354, pl. 15, f. 1 – 5. 1853.
" *verneuilii* : M'Coy, Brit. Pal. Fossils, p. 376. 1852.
" *disjunctus* : Murchison, Siluria, 2d edition, p, 299, f. 4. 1859.
" *barumensis:* Sowerby, MSS.; Salter, Jour. Geol. Society, Vol. 19, p. 480.
Spirifera disjuncta: Davidson, Monograph Brit. Dev. Brachiopoda, p. 23, 1864.
Delthyris perlata : Conrad, Ann. Rep. on Palæontology of New-York, p. 54. 1841.
" *chemungensis* : Conrad, Jour. Acad. Nat. Sciences of Philadelphia, Vol. 8, p. 263. 1842.
" *disjuncta?* Phillips; Hall, Geol. Rep. 4th Dist. New-York, p. 269, f. 3. 1843.
" *cuspidata:* Hall (not Martin), Ib., p. 270, f. 1. 1843.
" *acanthota:* Id. Ib., p. 270, f. 2, 2 *a*. 1843.
" *inermis* : Id. Ib., p. 271, f. 4, 4 *a;* p. 270. 1843.
Compare *Spirifer whitneyi*, Hall, Geology of Iowa, pa. 502, pl. 4, f. 2. 1859.

Shell variable in shape, semioval, semicircular or subrhomboidal : hinge-line usually as long as the width of the shell (rarely shorter), with the cardinal angles slightly rounded, moderately or extremely extended into long attenuated or mucronate points. Valves convex, or more or less gibbous : entire surface, including mesial fold and sinus, plicated.

Ventral valve more or less convex, usually with a regular convexity on the sides, but sometimes concave between the margins of the sinus and the extremities. The sinus is more or less deeply concave, rarely quite shallow, usually rounded but sometimes angular in the bottom, and the margins clearly defined : beak elevated and produced, moderately incurved over the area, which is flat or concave and of variable height. The fissure is often partially closed by an arching pseudo-deltidium.

Dorsal valve moderately convex, sometimes a little concave towards the cardinal angles : mesial fold distinctly defined, usually of moderate elevation and convexity, sometimes subangular, and often divided by a furrow down the centre : area very narrow.

Surface marked by from twenty to forty or more simple rounded or subangular ribs on each side, with nearly equal interspaces. The mesial fold and sinus are each marked by about ten, sometimes twelve or fourteen ribs near the front, which proceed from the bifurcation of two or three at the apex of each valve*. When the shell is perfectly preserved, the entire surface is marked by fine contiguous concentric striæ.

* Mr. Davidson says the increase is by intercalation; but strictly this is rarely true of our specimens.

The interior of the ventral valve shows the presence of more or less extended dental lamellæ : these are sometimes short and divergent, enclosing a pretty broad muscular space, and often less divergent and reaching nearly to the front of the shell; and the muscular imprint is sometimes pushed very far forward, and enclosed in a narrow space. The muscular markings are often well defined in the casts, but in some of them the markings of the ribs are shown over the muscular space. The fissure is closed for one-third or more of its length from the apex by a thickened plate or septum, with the rostral cavity more or less extended behind it. In casts of the dorsal valve, we have the imprints of the cardinal muscles and the cavities made by the bases of the crura.

This species has been recognized by European authors as *Spirifera disjuncta*, and identical with *S. verneuili*, etc., as shown in the synonymy. From comparison of ours with European specimens of that species in my own collection, I can find no important distinction; indeed the differences in a few individuals are not as great as those among our own specimens recognized as belonging to the same species. It is regarded in Europe as a very characteristic Middle and Upper Devonian species; but in the State of New-York, it is not known out of the Chemung group.

The *Spirifera whitneyi* is from beds of the age of the Hamilton group in Iowa, and bears a very close resemblance to the *S. archiaci* as figured in the Geology of Russia (ut cit). Some specimens of this form more recently examined* show a variation in aspect and general characters which induce the conclusion that this one also is only a variety of *S. disjuncta*, occurring at a lower horizon in the west than yet known in New York; thus giving it a vertical range equal to the Middle and Upper Devonian of Europe.

I have heretofore† given some of the varieties of this species under distinctive names, which have been abandoned after the study of larger collections. I have also been able to satisfy myself with regard to the

* Specimens received from Mr. O. St. John, of Waterloo, Iowa.

† Geological Report of the Fourth District of New-York, pp. 270, 271.

identity of our species with those given by SOWERBY and PHILLIPS under different designations, and have adopted the synonymy given by DAVIDSON, DE KONINCK, DE VERNEUIL, SOWERBY and others, under this species. It has a wide geographical extent and great vertical range in the Chemung group, and presents a variety of form and proportions which it would be quite impossible fully to illustrate. The more important phases I have endeavored to show in the figures on Plates XLI and XLII : the greater number of these are of casts.

The predominating characters of the casts of ventral valves are shown in 1 – 4 and 7, 8, 10, 13, 19 & 20 of Plate XLI.

In figure 5 we have a form where the dental lamellæ are extremely extended towards the front of the shell, and fig. 15 is somewhat similar. This extreme character has been observed more frequently in the small gibbous forms, but it likewise occurs in the large and less convex ones. The extremely extended forms with mucronate extremities are less common than the others; but in some localities, nearly all the individuals found have that character.

The form represented by figures 19 and 20 of Plate XLI, and by figure 19 of Plate XLII, is that described by Mr. CONRAD as *Delthyris perlatus**, and is cited by Mr. VANUXEM† as *Delthyris prolata*. The *Delthyris chemungensis*‡ of CONRAD is thus described :

"DELTHYRIS CHEMUNGENSIS. Triangular, ventricose, with numerous slender ribs; upper valve with the mesial fold wide, convex or rounded and ribbed like the sides, except that the ribs bifurcate, about thirteen in number; area of inferior valve very wide; mesial fold profound. Length, one inch; width, one inch and a half. Locality, Chemung-narrows, New-York : in Devonian shale."

There is no other Spirifer known to me in the locality cited, or in the Chemung group, which will correspond with the description, except the *Spirifera disjuncta*.

One of the remarkable features in the dorsal valve is the duplication of the mesial fold, or the marked longitudinal furrow along the centre. This feature can be observed in all gradations; and while in some localities there is scarcely a specimen to be found having this character, in other places it prevails in the larger number of individuals. This depression is usually narrow and sharp, but in some individuals it is broader, as shown in figures 13, 15, 16, Plate XLII. The fold is

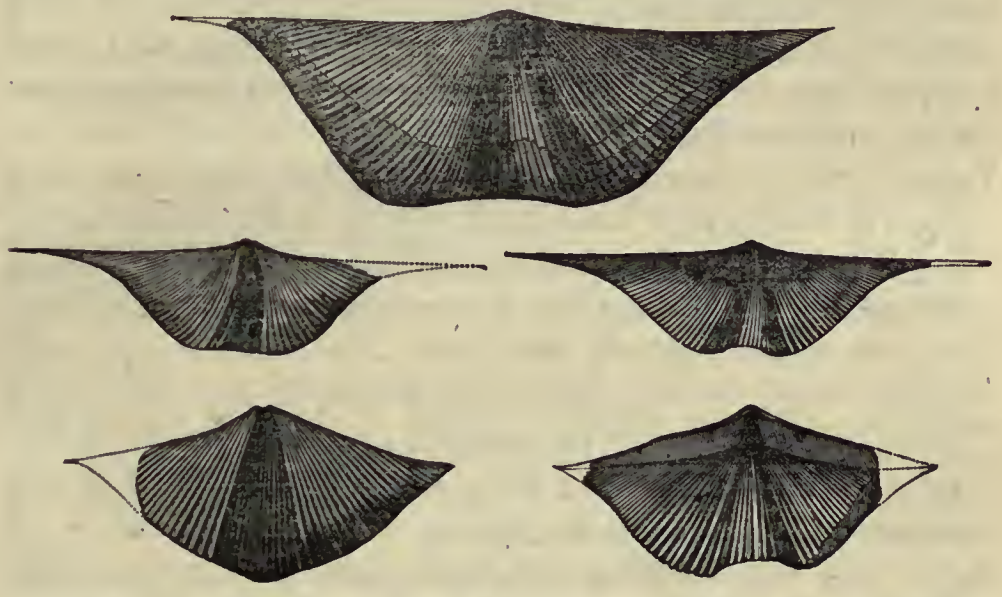
* Annual Report on the Palæontology of New-York, p. 54. 1841.

† Report on the Third Geological District of New-York, pp. 179, 185.

‡ Journal of the Academy of Natural Sciences of Philadelphia, Vol. viii, p. 263. 1842.

very rarely narrow and angular, as shown in fig. 17. The casts usually preserve more or less distinctly the marks of the plications, and are rarely almost smooth.

The following figures are those which were given in the Geological Report of the Fourth District, and have not been repeated in the plates. They offer some little variety of form and proportions from those already referred to.*



Geological formation and localities. This species occurs in the Chemung group throughout New-York, and in that part of Pennsylvania adjacent to the south-western counties of this State. Among the particular localities may be mentioned several places in Broome county; Cayuta creek in Tompkins and Tioga counties; Factoryville, Chemung-narrows, Chemung, Paintedpost and Elmira, in Chemung county; near Angelica, Vandemark's creek, Olean, and other places in Allegany county; Troupsburgh, near Bath, and elsewhere in Steuben county; at Salamanca, Allegany station, New-Albion, Napoli, Randolph, Connewango, Great-valley, Leon, etc. in Cattaraugus county; at Ellington, Twenty-mile creek, and other places in Chautauque county.

In Pennsylvania, I have collected this species from Covington and localities to the north of Blossburg, and Mr. R. P. Stevens has sent me specimens from near Bradford. It is abundant at Meadville and vicinity.

* The illustrations in wood cuts were given in the Geological Report of the 4th District as 1 *Delthyris cuspidata*, 2 and 2*a*; *D. acanthota*, 4 and 4*a*; *D. inermis*.

Spirifera alta (n. s.).

PLATE XLIII.

Shell semipyramidal, triangular in form from the ventral or cardinal sides, and semioval in a dorsal view; cardinal line equalling the greatest width of the shell, and sometimes produced in short auriculate extensions : surface plicate.

Ventral valve extremely elevated, subtriangular; height and width about as three to five : sinus broad rounded in the bottom, and extended from beak to front. Area very large, triangular, acute, inclining forward or nearly rectangular to the general plane of the dorsal valve, strongly striated vertically. The fissure is large but comparatively narrow, being more than twice as high as its width at the base, and is closed by a concave transverse septum for two-thirds of its length from the apex. The margins of the fissure are grooved, as in other species, for the reception of a pseudo-deltidium.

Dorsal valve large, somewhat semioval, depressed-convex or but moderately convex at the sides, with a broad and well-defined mesial fold : the cardinal angles are sometimes obtusely rounded or truncate, and sometimes a little produced. Area comparatively wide, and strongly striated vertically.

Surface of the dorsal valve plicated by about twenty-five to thirty or more low rounded ribs on each side of the mesial fold : in the casts, half the number are often quite obscure towards the extremities. The mesial fold and sinus are plicated, and the ribs are faintly preserved, or sometimes barely visible in the casts. In casts of the ventral valve, the plications are scarcely preserved except towards the margin.

There is a distinctly ovate muscular impression in the ventral valve, with indications of a low crest in the centre; while the dental lamellæ are only extended for half the length of the muscular space, yet they continue to form the walls of the fissure to its base; but we have no evidence of the teeth, except in the character of the teeth-sockets in

the opposite valve. The casts of the dorsal valve show the marks of a deeply striated cardinal process and elongate teeth-sockets, while the muscular impressions are sometimes strongly marked.

This species is known to me only in the condition of casts of the interior, and its usual appearance is illustrated in the figures on Plate XLIII. Its general aspect is much like that of the European *Spirifera cuspidata*, MARTIN; but there are important differences by which it may be distinguished : these are, the plications on the mesial fold, the larger area of the dorsal valve, and the shorter extension and greater divergence of the dental lamellæ by the sides of the muscular impression. Some of these characters, I conceive, are not likely to change to those shown by *S. cuspidata*. In the concave septum closing two-thirds of the fissure from above, it resembles that species as described by Prof. M'COY, who mentions the presence of a "deep-seated pseudo-deltidium."* In one of the figures given by Mr. DAVIDSON and referred with doubt to this species†, the cast shows a tubular perforation in the filling of the fissure; and a gutta percha impression from the same shows the mark of a foramen, but there is no positive evidence of a septum which is so conspicuous in our specimens, and which I suppose to be the feature characterized by Prof. M'COY as a deep-seated pseudo-deltidium. In our species, I have not been able to discover any corresponding perforation; the only indication of this being the semicylindrical impression along the centre of the fissure (in the cast), showing a callosity of the septum behind the exterior wall.

In form and proportions, this species bears a very close resemblance to one in the Waverly sandstone of Ohio, and also to one in the fine-grained sandstone of Burlington, Iowa; but of neither of these have I the necessary material for satisfactory comparison. It differs from the *S. subcuspidata*‡ of SCHNUR in the plications on the mesial fold and sinus, and the wider area of the dorsal valve; and also in the same characters it differs from the *S. textus* of the sandstone and argillaceous limestone near New-Albany, Indiana.

Geological formation and locality. This fossil occurs in finegrained ferruginous sandstone of the Chemung group, at Meadville, Pennsylvania; associated with *Spirifera disjuncta*, *S. prœmatura*, *Streptorhynchus chemungensis* var. *pectinacea*, *Chonetes muricata*, *C.* ?, *Productus* (*Productella*) *lachrymosa*, etc.

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* * * * *; triangular opening very large, often displaying the internal deep-seated pseudo-deltidium (without perforation, leaving the only opening to the shell at its base); * * *. McCOY, British Palæozoic Fossils, p. 426.

† Monograph of British Carboniferous Brachiopoda, Plate ix, f. 1 & 1 *a*.

‡ *Spirifer subcuspidatus*, HALL, Geological Report of Iowa, pa. 646, pl. 20, f. 6, is a distinct species, and apparently identical with *S. textus*, HALL, Tenth Report on the State Cabinet, p. 160 : 1857. See Nineteenth Report on the State Cabinet, for remarks on this species.

Spirifera præmatura (n. s.).

PLATE XXXII.

Compare *Spirifer pseudolineatus*, HALL, Geology of Iowa, pa. 645, pl. 26, f. 4. 1859.
Compare *Spirifer hirtus*, WHITE & WHITFIELD, Proc. Bost. Nat. Hist. Society, Vol viii, p. 293. 1862.

SHELL transversely oval or suborbicular; hinge-line shorter than the width of the shell, with the cardinal angles rounded : surface not plicate.

VENTRAL valve moderately convex, sometimes subventricose, with a broad and rather shallow sinus, the margins of which are not strongly defined : beak moderately elevated and incurved; area small, the lateral margins undefined.

DORSAL valve regularly and moderately convex, with a scarcely defined mesial elevation, which becomes broad and more conspicuous towards the front of the shell.

SURFACE marked by numerous regular subimbricating concentric lines, crossed by coarse radiating striæ : these are often continuous, but always more conspicuous on the concentric lines or ridges, sometimes giving a pustulose appearance to the surface.

The casts or partial casts sometimes preserve the radiating striæ more distinctly than the concentric lines. In the perfect shell, the radiating striæ were doubtless produced from the concentric ridges into minute spinules.

The casts of the ventral valve show the cavities of rather slender but sometimes considerably elongated dental lamellæ. The muscular area is somewhat narrow, and only rarely are the parts well defined. There is always a longitudinal impression indicating a median crest or low septum from the apex of the rostral cavity.

The condition of the specimens is not such as to enable me to give a full description of the species. They are either casts in friable ferruginous sandstone, or partial casts preserving some of the surface markings; while some specimens in a shaly bed have been macerated till the surface characters are obscured. It clearly belongs to the group of Spirifers of which *S. lineata* is the type, and is closely

allied to *S. pseudolineata* of the Keokuk limestone. The specimens of *S. hirtus* in my possession are very imperfect, and do not afford fair means of comparison; but I am much inclined to the opinion that an examination of a larger number of the Burlington species with ours will prove them identical. Both are known to me only in casts, and those from the western locality do not offer sufficient grounds for a satisfactory specific distinction. I shall nevertheless indicate this as distinct for the present; hoping to obtain material to show the identity of *S. pseudolineata*, *S. hirtus*, and *S. prœmatura*.

This species is associated with great numbers of *S. disjuncta*, *Streptorhynchus chemungensis* var. *pectinacea*, *Productus lachrymosa* var., *Chonetes muricata*, *C. setigera*, and a CHONETES with about fifty fine striæ, with regular intermediate puncta as in *C. illinoisensis*.

The lower line of figures on Plate XXXII are of this species in its condition of casts, the smaller one partially retaining the shell.

The small figure above (fig. 32) is the ventral valve of a young individual, having the beak unusually extended and the concentric undulations strongly marked.

Figures 32 and 33 are dorsal valves of this species.

Figures 34 and 35 are the casts of ventral valves, showing, in the space between, the dental plates and extent of muscular impression.

Geological formation and locality. In the Chemung group at Meadville, Pa., and among specimens lately received from Oil Creek, associated with *Spirifera disjuncta*.

SOME important considerations are suggested by the study of *Spirifera prœmatura*, *Spirifera alta*, and their associates.

The species which I have here designated as *Spirifera prœmatura* exhibits no external markings which enable one to say that it is distinct from *S. hirtus* of the sandstones at Burlington, Iowa; nor does it present differences from *S. pseudolineata* which may not be reconciled with geographical influences, and with a habitat nearer to the shore line and the essential absence of calcareous matter in the sediments deposited. Its associates, however, are of different species from those in the western locality; but still among the more conspicuous of these is *Spirifera alta*, *Productus lachrymosa* var., and *Chonetes muricata*, which have a carboniferous aspect; and were it not for the presence of *Spirifera disjuncta* and one or two others, the general aspect of the fauna might be termed carboniferous.

If again we look at the characters of *Spirifera alta*, an analogue or representative of *Spirifera cuspidata*, we have many points of similarity with one or more species in the rocks of the West and Southwest which are usually referred to a

higher position. The high area and the transverse concave septum, which is not a true pseudo-deltidium, allies it with *Spirifera textus*, in which we find similar features. In the *S. alta* there has probably been an external convex pseudo-deltidium, and between this and the septum closing the fissure there has been a narrow space. This septum, which is an extension of the dental lamellæ, has been thickened or expanded on the inner side, as shown by the casts of the ventral valve; and in several specimens there is a narrow semicylindrical depression extending nearly to the beak of the valve.

In comparing this species with *Spirifera textus*, we find similar conditions, or more properly an extension or amplification of the same features. In that species there is a convex arching pseudo-deltidium, though rarely preserved in the specimens. Beneath this there is a concave septum, and upon the inner face of this there is a tubular callosity; or, in other words, the inner laminæ of the septum become fistulous, and enclose a cylindrical or subcylindrical space, which extends from the base of the septum to near the apex of the valve*. But more usually the laminæ appear to be separated, and, extending inwards, are recurved, their edges sometimes joining to form a tube; but more frequently perhaps the margin of each one is recurved upon itself, leaving the tube with a slit along the lower side. In some instances, however, these extensions from the inner face of the septum continue to the bottom of the cavity, and, joining the external shell, leave a quadrangular tube instead of a cylindrical one.

It is evident from what has been said, as well as from the illustrations given, that there is a near approach to this character of *S. textus*, or an incipient step towards it, in *Spirifera alta ;* but the feature has not become fully developed. We have the concave septum with a semicylindrical callosity on its inner face, but this ridge has apparently remained solid. The concave septum, however, must not be confounded with the pseudo-deltidium : the latter is apparently an independent growth of shelly (or sometimes perhaps scarcely solid shell) matter, forming an exterior plate from the apex of the fissure, covering to a greater or less extent the opening, but apparently not connected with, nor a part of the dental lamellæ or substance of the area, while the septum is an outgrowth or lateral extension of the dental plates.

In the case of *Spirifera alta*, the extension of the septum is so great, that when connected with the general form of the shell, its nearest analogue appears to be *Spirifera textus ;* which, so far as I can now determine, is identical with the one described by me as *S. subcuspidatus* in the Geological Report of Iowa. The latter is a carboniferous species from the Keokuk limestone, and closely allied to the

* It is upon this feature, or one of similar character, in its full development, that I understand Prof. WINCHELL proposes to found the Genus SYRINGOTHYRIS.

Spirifera cuspidatus of Europe; and the Chemung species thus reminds us of the Carboniferous one, or has a carboniferous aspect.

If, in its full development, the presence of a septum and internal tube be regarded as of generic value, then we have in *Spirifera alta* the same appendages in part, or in a partially developed condition; the distinct tube only being wanting. But had we the means of examining the internal characters of the ventral valves of all the species of Spirifers, we should probably find gradations from the solid filling of the rostral cavity, with a greater or less extension of shelly matter in the form of a septum in the fissure occupying a narrow space in its apex, till we reach the development observed in *S. alta* and *S. textus*.

To a considerable extent, we are able to prove this supposition. In the separated valves of *Spirifera radiata* of the Clinton and Niagara groups, there is a filling of the rostral cavity, and a thickening of the dental lamellæ which are extended for half the length of the valve. The narrow median crest of the muscular impression is expanded and thickened towards the apex of the valve, but there is no evidence of a septum. In *Spirifera niagarensis* there is a filling of the rostral cavity and a thickening of the dental lamellæ, which are distinctly separate, but no appearance of a septum; and there is a low median crest in the muscular impression.

In the Lower Helderberg group, the *Spirifera macropleura* has the rostral cavity filled to a greater or less extent, and the dental plates extremely thickened at their bases; while there is an obscure low median crest in the muscular impression, which sometimes becomes thickened and expanded above; and occasionally there is a little filling of the upper part of the fissure, resembling the incipient stages of growth of the septum. In *Spirifera cycloptera* the rostral cavity is more or less filled and solid, with diverging dental lamellæ; while the crest dividing the muscular impression is very unequally developed, and there is no appearance of a septum. In *Spirifera perlamellosa* the rostral cavity is filled to a greater or less degree, the dental lamellæ are short and strong, and there is a sharp elevated median crest or septum in the muscular impression; but there is no indication of the transverse septum. In *Spirifera octocostata* the dental lamellæ are thickened, and there is a *vertical* septum reaching from the apex of the rostral cavity to the base of the muscular impression. In *Spirifera marylandica* of the Oriskany sandstone, there is sometimes a partial filling of the rostral cavity, with a reversed conical crest in the upper part of the muscular area. *Spirifera arenosa* has strong dental lamellæ; a filling of the rostral cavity in old shells; a low crest dividing the muscular impression, which becomes thickened in its upper part; a distinct pseudo-deltidial covering of the fissure, but no transverse septum.

Among the Spirifers of the Upper Helderberg group, *Spirifera acuminata* has usually only a moderate thickening of the rostral portions, divergent lamellæ of

moderate strength, and no transverse septum. In *Spirifera oweni* the rostral cavity is partially filled; the dental lamellæ are thickened; there is a reversed conical callosity at the apex of the cavity, the attenuated continuation of which divides the muscular area : the fissure is closed by a thickened plate or septum for one-half its length from the apex. In *Spirifera raricosta* the rostral cavity is filled; the dental lamellæ are short and thick; the fissure is closed by a solid filling for a part of its length, while from the bottom of the cavity there rises a thin vertical septum which extends to within one-third the length of the front of the valve. In *Spirifera gregaria* the rostral cavity is more or less filled with thickened dental lamellæ, and sometimes the incipient growth of a transverse septum is perceptible.

In several of the Spirifers of the Hamilton group the septum is well marked, while in others there is an incipient development of the same character. In *Spirifera granulifera* the upper part of the rostral cavity is filled with shelly matter, and this apparently encroaches upon the space below with the advancing age of the shell. The fissure becomes partially filled, and a thickened plate projects a little in advance of the solid filling of the beak; leaving behind it, or on the inner side, a conical cavity directed towards the apex of the shell. The muscular area is divided by a low longitudinal crest, which, in its extension towards the beak, becomes wider, and is often much thickened towards its junction with the solid shelly matter filling the rostral cavity. Looking at this from the apex of the shell, it presents a subconical form, and is more or less abruptly attenuated towards the centre of the muscular impression. This callosity sometimes becomes so prominent as to produce an emargination or indentation in the apex of the cast, and a similar feature is sometimes observed in the casts of other species of SPIRIFERA.

Regarding the *S. granulifera* alone, there is little to attract especial notice, beyond the general fact of a partial filling of the rostral cavity with the exterior portion prolonged between the dental lamellæ, but so much thickened as scarcely to merit the term septum. In *Spirifera marcyi* this development of shelly matter has the character of a true septum, closing one-third or more of the length of the fissure from above, aad leaving an open rostral cavity behind it. In *Spirifera medialis* and *S. macronota* there is a thickened transverse septum extending from one-third to one-half the length of the fissure from the apex, and this feature is quite independent of the pseudo-deltidium. The rostral cavity lies behind this septum, and may be open or free from the accumulation of shelly matter to a greater or less extent; but it is not uncommon to find nothing more than a thickening of the base of the dental plates and a partial filling of the rostral cavity. This condition changes to a greater or less extent during the growth of the shell; but a partial filling of the fissure at its apex is probably more common than otherwise, particularly in full-grown individuals.

In the Spirifers of the Carboniferous rocks which I have been able to examine, this feature is variably developed. In *S. plena* of the Burlington limestone, the septum extends for more than half the length of the fissure; while it is less developed in *S. grimesi*, and scarcely at all in *S. increbescens* and *S. opima*.

The shell texture of SPIRIFERA is usually regarded as fibrous, and this is true of all those I have examined in the older strata, though in some of the species of the higher formations, characters have been observed, which, with imperfect means of investigation, seem to be irregularly distributed ducts penetrating the shell. I have not been able to examine the shell of *Spirifera alta*, to learn whether any changes have taken place in its texture, not observed in other species of SPIRIFERA; but in *S. textus*,* where the septum and tube are developed, the shell is penetrated by numerous pores or ducts which are somewhat coarser than the ordinary punctate structure of some other Brachiopoda; and though not in actual contact, are often arranged in regular order and frequently in close proximity to each other, not essentially differing from those of SPIRIFERINA as given by Dr. CARPENTER. The intermediate spaces have a distinctly and beautifully fibrous or prismatic structure, differing in no respect from ordinary Spirifers or ATHYRIS.

It should be observed, in this connexion, that the dental plates, both in *Spirifera alta* and *S. textus*, reach to the bottom of the cavity, and partially surround the muscular impression, which is precisely like that of ordinary Spirifers.

In these remarks, I have not intended to express an opinion of the generic value of certain characters; but merely to show, as it appears to me, a gradual or successive development in certain parts, which finally becomes so wide a departure from the characters of typical forms of SPIRIFERA, as to deserve especial attention. Nor can we deny that this progressive development of the septum and its modifications keeps pace and corresponds with the geological succession; reaching its extreme state, so far as now known, in the Carboniferous period, where it is connected with a punctate texture of the shell.

In our investigations of the Chemung group in its more easterly extension in the State of New-York, it has proved, throughout the greater part of its thickness, to be comparatively barren of animal organisms, though often containing an abundance of the remains of land vegetation. As we progress westerly, the coarser sediments have given place to finer materials, or are more or less intercalated with shales or shaly and calcareous beds, while the coarser beds exhibit less resemblance to shore deposits, and we find an increasing number of animal remains both of the

* In this species, and in *Spiriferina spinosa* of NORWOOD & PRATTEN, the pores or ducts are unequally distributed; being, in some parts of the shell, closely crowded, while in others they are more distant and often following the line of growth, though frequently irregularly disposed.

Prof. WINCHELL remarks, of the proposed Genus SYRINGOTHYRIS, that "the shell is impunctate in all conditions and under high powers."

Brachiopoda and Lamellibranchiata, though there are usually few of any other class. But these are not equally distributed, either vertically or horizontally.

There is one fact, however, which can scarcely fail to impress the collector of fossils in this group of strata; which is, that in going westward, certain forms which are abundant in some localities become rare or disappear altogether, so that sometimes localities not very far removed from each other give almost entirely a different set of species. Certain species which are common in Schoharie, Broome, Tioga and Chemung counties, I have not seen in Cattaraugus and Chautauque counties; while many species which are common in the western counties are quite rare or unknown to me in Tioga, Tompkins, and the counties east of these. Although we may attribute this view in some part to our imperfect collections, it is nevertheless in a great degree true.

Reasoning upon the nature and origin of the sediments, as well as upon these observed conditions, we might expect to find a changing fauna as we recede from the ancient coast line furnishing these materials, and which were then swept into the wide ocean to the westward. While in some of the more eastern localities we find species of the Hamilton group apparently mingling with those of the Chemung group, the higher beds of Cattaraugus and Chautauque counties give us an association of fossils having a more carboniferous aspect than those of the higher beds in the eastern counties of the State.

As we proceed farther to the westward, these differences become more and more marked; and in connexion with the contemporaneity of the sedimentary formations in distant localities holding dissimilar species, we must consider the gradual lithological changes which have affected the character of the fauna. There can be no longer any question that the higher arenaceous and argillaceous formations of New-York and the adjacent portions of Pennsylvania and Ohio, when traced in a southwesterly direction, become intercalated with calcareous bands; while the coarse sediments give out, or are replaced in a great degree by calcareous or argillo-calcareous deposits, containing some of the same species of fossils, with an accession of other forms adapted to the changed conditions of life.*

In the extreme southwestern extension of the Palæozoic series, the interval between the Upper Helderberg group and the Coal Measures, which in the North is occupied by the Hamilton, Portage, Chemung and Catskill formations constituting so marked a feature in New-York, Pennsylvania and Ohio, is there filled by calcareous accumulations that have been considered as belonging exclusively to

* I have already shown a similar condition existing at the period of the Coal Measures; where some calcareous bands of a few feet thickness in Ohio, Pennsylvania and Virginia, become expanded so that, together with the associated calcareous shales, they embrace almost the entire formation towards the Rocky Mountains and in the far west and southwestern regions of the United States and in Mexico.

the Carboniferous system; so that the limestones of this age are supposed to rest directly upon the Silurian rocks, or with a thin intervening Devonian limestone. But we can scarcely suppose that the lapse of time required for the northern sedimentary formations remained unrecorded by fauna of some kind, while the interval is filled by an accumulation of a thousand or more feet of calcareous deposition.

It here becomes a matter of grave interest to decide what shall constitute the *fauna Devonian*, and what may be regarded as the *fauna Carboniferous*. Looking at the great number of Productus (for although I have used the term Productella as indicating certain distinctions, the fossils are in all essential respects Productus) in the central and western portions of the State, they alone would give a Carboniferous aspect to the fauna. But when we find *Spirifera disjuncta*, and other fossils of acknowledged Devonian age, we instinctively allow less than the due importance to the Carboniferous evidence. Nevertheless we are forced to admit, even within the State of New-York, a gradual diminution of the Devonian type, and an augmentation of the carboniferous type, in the same beds as we go westward. And finally, we have every reason to believe that in those sedimentary formations, between the Hamilton group and the Coal measures in the east, and between the same group and the Burlington (Carboniferous) limestone in the west, the Devonian aspect of the fauna on the one hand, and its Carboniferous aspect on the other, are due to geographical and physical conditions, and not to difference in age or chronological sequence of the beds containing the fossils.

This view of the case, which is consonant with the facts observed, will account for the coming in of forms which we term Carboniferous, as we pursue our investigations to the westward.

The same opinions seem gradually to be obtaining ground in Great Britain, but the idea is not new with me. It is now about fifteen years since I expressed similar opinions in a review and comparison of the Palæozoic groups and systems of Europe and America.

In some of the concluding paragraphs of the eighteenth chapter of Foster & Whitney's Report on the Lake Superior Land District, after having made a comparison of the species cited as common to the Silurian and Devonian and to the latter and the Carboniferous system, I have said :

"The arenaceous and argillaceous deposits, which we trace uninterruptedly over so wide an area, and which present to us such gradual and almost imperceptible changes in the fauna when studied continuously, would, if broken up and isolated so that they could not be traced consecutively, present the same phases which are exhibited by the systems in Europe to which they are related. From all these facts there seems to be but one conclusion, and that is, in the British Islands particularly, either there are remarkable exceptions to the general law in the continuation of species from one to another, or there is no foundation for a distinction between the Devonian and Carboniferous systems."

Subgenus Ambocœlia.

In the Thirteenth Report on the State Cabinet*, I proposed the name Ambocœlia as a generic designation for several species of fossils, of which *Orthis umbonata* of Conrad was regarded as the typical form. This fossil bears much resemblance to *Spirifer urii*, Fleming = *S. unguiculus*, Phillips; but I do not regard the identity of the two as demonstrated at the present time. The European species has been placed by King and M'Coy under the Genus Martinia of the latter; the typical species of which, mentioned by M'Coy its author, are *Spirifera decora*, *S. elliptica* and *S. glabra*†. These European species are not more nearly related to *Orthis umbonata* than are some of our own species, in which we observe the ordinary characters of the Genus Spirifera.

But there are a few points of distinction between these and the form I have proposed to designate Ambocœlia. Whether these are of generic importance, may remain a question; but they differ from those on which the Genus Martinia was founded, and the allied species *Spirifera urii* = *S. unguiculus* was only included under the genus at a later period‡; so that if that one be proved generically distinct from Spirifera, it could not supersede the type of the genus indicated by M'Coy.

In the ventral valve, the thickened margins of the fissure are produced in short strong teeth; but there is scarcely any extension of the dental plates into the cavity, or below the inner margin of the fissure.

In the dorsal valve, the bases of the crura continue attached to the inner surface of the valve for more than one-third of its length, before becoming free. There is a lateral projection from these crural bases,

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* Thirteenth Annual Report on the State Cabinet of Natural History, pp. 71 & 72. 1860.

† Synopsis of the Carboniferous Fossils of Ireland, p. 139 (1844). Mr. Davidson, in his Monograph of British Carboniferous Brachiopoda, places *S. decora* as a variety of *S. glabra*, and *S. elliptica* as a variety of *S. lineata*; while *Martinia oblata*, *M. obtusa* and *M. symmetrica* are regarded as simply varieties of *Spirifera glabra*, and *Martinia mesoloba* and *M. stringocephala* as varieties of *S. lineata*.

‡ British Palæozoic Fossils, p. 377. 1855.

bounding the teeth-sockets. The cardinal process is elongate, lying between the crura, and is distinctly bifurcate or bilobed at the outer extremity as in CYRTINA. The muscular impressions are below the middle of the valve, often near the front, and are usually distinctly quadruple. The dorsal valve being depressed-convex, flat or concave, the spires lie in the cavity of the ventral valve : no peculiarity has been observed in those appendages.

With these remarks, I shall for the present leave the following species under the designation of AMBOCŒLIA.

Ambocœlia umbonata.

PLATE XLIV.

Orthis umbonata : CONRAD, Jour. Acad. Nat. Sci. Philadelphia, Vol. viii, pa. 264, pl. 14, f. 21.
" " : CONRAD; HALL, Tenth Report on the State Cabinet, p. 167. 1857.
Ambocœlia umbonata : (CONRAD sp.); HALL, Thirteenth Report on State Cabinet, pp. 71 & 72. 1860.
Orthis nucleus : HALL, Geol. Report Fourth District, pp. 180 & 181.
Ambocœlia nucleus : HALL, Thirteenth Report on the State Cabinet, p. 71.

SHELL plano-convex, somewhat semiorbicular or obliquely subconical, rather wider than long; hinge-line equal to the width of the shell or rarely a little less, the cardinal extremities rounded.

VENTRAL valve gibbous, with the umbo extremely elevated and a comparatively large incurved beak : mesial sinus distinct, extending from the beak to the front of the shell; the area rather large, arched and of considerable height, extending conspicuously to the cardinal extremities. The fissure is partially arched over by a pseudo-deltidium.

DORSAL valve semielliptical, depressed-convex in the upper central portions, concave below the middle and at the sides : apex scarcely elevated above the hinge-line; area equalling the thickness of the shell. There is no perceptible mesial fold, furrow or impressed line in this valve.

SURFACE marked by very fine radiating and concentric striæ; the latter sometimes becoming crowded, lamellose and imbricating towards the front of the valves.

The interior of the ventral valve shows a comparatively strong tooth on each side at the base of the fissure, which is continued in a callosity

along its inner margins. I have not observed any extensions of dental lamellæ into the cavity of the shell. (There appear to be no proper dental plates, but simply a thickening of the margins of the fissure.) The muscular impression is in the upper part of the valve.

The interior of the dorsal valve usually presents a quadruple muscular imprint towards the front of the shell, with the bases of the crura attached along the inner surface for a considerable distance, and a bilobed cardinal process.

The casts of the ventral valve sometimes show a median depression in the upper part, and impressed lines slightly limiting the muscular imprints, as if made by a blunt ridge in the shell; but more frequently there are no marks of this kind.

The small shell in the Marcellus shale which I originally designated as *Orthis nucleus*, is, I conceive, only a smaller form of this species, in which the median sinus is often very conspicuous, being narrow and sharply depressed. It sometimes occurs in the compact calcareous beds of the Hamilton group in great numbers, of a similar diminutive size; and in these the dorsal valve is more convex than usual. In the shales of the Hamilton group this fossil is often extremely abundant, and in a fine state of preservation. The illustrations of the interiors of the valves are of specimens from this group.

Figs. 1, 2, 3. Dorsal, ventral and profile views of *Ambocœlia umbonata*. natural size, from the shales of the Hamilton group.
Fig. 4. The interior of the ventral valve showing foramen, area, etc. enlarged.
Fig. 5. Interior of the dorsal valve enlarged, showing the foveal plates, dental sockets, and the quadripartite muscular impression; the valve slightly distorted.
Fig. 6. A similarly enlarged dorsal valve, showing some variations from the preceding.

Geological formations and localities. In the Marcellus shale, at Avon and other places. In the Hamilton group, it occurs everywhere from Schoharie county to Lake Erie: among the principal localities may be mentioned the shores of Seneca and Cayuga lakes; the shore of Canandaigua lake; Geneseo, Moscow, York, Covington, Darien; and on the shore of Lake Erie at Hamburgh and Eighteen-mile creek.

Ambocœlia umbonata, var. gregaria.

PLATE XLIV.

Orthis unguiculus : (PHILLIPS sp.); HALL, Geol. Report Fourth District, pp. 267, 268. 1843.
Ambocœlia gregaria : HALL, Thirteenth Report on the State Cabinet, p. 81. 1860.

The shell occurring in the Chemung group, and indicated by me as a distinct species of this genus, possesses so many characters in common with the Hamilton forms that I hesitate to continue the specific designation.

The ventral valve is often more elongated, and the margins of the mesial sinus are subangular. The dorsal valve is depressed convex, with a distinct median sinus as shown in the casts. The casts of the interior of the ventral valve show a longitudinal median crest in the muscular impression, which is also often limited at the sides by a linear obtuse impressed line, as if by some callosity on the interior of the shell.

Some of the specimens in the Chemung group attain larger dimensions than any of those in the Hamilton, being often nearly half an inch in diameter.

This form, with its convex dorsal valve, bears much resemblance to the *Spirifera urii** of Europe, which, according to Mr. DAVIDSON, passes from the Devonian through the Carboniferous, and occurs in the Permian system. It is described by Mr. DAVIDSON as having a narrow mesial furrow in the dorsal valve, which is "nearly flat or slightly convex". This author remarks : "The external surface, where perfect, is covered with small spinules". Although the shell of this fossil in the Hamilton group is apparently in a very perfect condition, I have been quite unable to discover any evidence of the existence of spinules or their bases, a character observed in Spirifers allied to *S. lineata.*

Geological formation and localities. This variety occurs in the shales and shaly sandstones of the Chemung group, near Binghamton, at Chemung and Chemung-narrows; near Elmira, at Corning, Paintedpost, and along the Corning and Blossburgh railroad; at Jasper in Steuben county; near Olean in Allegany county; at Randolph, Albion, and Connewango in Cattaraugus county; Gerrytown-corners, Cherry-creek, Ellington and other places in Chautauqua county.

**Atrypa unguiculus,* SOWERBY = *Spirifera unguicula,* PHILLIPS, is regarded as a synonym of *S. urii.*

Ambocœlia præumbona.

PLATE XLIV.

Orthis præumbona : Hall, Tenth Report on the State Cabinet, p. 167. 1857.
Ambocœlia præumbona : Hall, Thirteenth Report on the State Cabinet cited, p. 71. 1860.

Shell obliquely semiglobose or ovoid, the hinge-line less than the width of the shell; cardinal extremities rounded : surface without plications.

Ventral valve extremely convex or ventricose, with a shallow impressed line which has nearly the character of a narrow shallow sinus : beak large and incurved; area of moderate dimensions, proportionally high, with the lateral margins not defined; fissure partially covered by an arching pseudo-deltidium.

Dorsal valve moderately and evenly convex, usually without mesial fold or sinus, the cardinal extremities rounded. Sometimes there is a narrow impressed line down the centre of the valve.

Surface essentially smooth, or marked only by concentric striæ, which are sometimes crowded into imbricating folds. In rare examples, I have observed towards the margin a kind of punctate marking, which does not belong to the texture of the shell, and may indicate the bases of seta; but the evidence is unsatisfactory.

Little is known of the interior of the valves. The cast of the ventral valve has a large often pustulose muscular area, margined by a thickening of the shell; without evidence of dental plates. The dorsal valve has a bilobed cardinal process, with the bases of the crura extended along the inner surface of the valve.

In many specimens of this shell the length and width are nearly equal, the dimensions being about three-fourths of an inch. In some individuals there is an extreme elongation of the ventral valve, as shown in figure 5 *a* of Plate xliv. Its greater size and absence of mesial sinus, and proportionally shorter hinge-line, distinguish this species from *Ambocœlia umbonata*.

Geological formation and localities. This species occurs in the soft shales of the Hamilton group, on the shores of Seneca and Cayuga lakes, and upon Canandaigua lake. Though sometimes abundant in certain layers in a few localities, it is far from having the wide geographical range of the *Ambocœlia umbonata*.

CYRTIA of DALMAN, and CYRTINA of DAVIDSON.

FOLLOWING the general external characters of certain spiriferoid forms, as described by DALMAN in his definition of CYRTIA, those with semiconical or semipyramidal ventral valves, high flat areas, with a narrow fissure closed by a convex pseudo-deltidium, have been referred to that genus. In some of these, there is a round perforation in the upper part of the pseudo-deltidium; but this feature may be present or absent, and has not been regarded as of generic significance. The types of DALMAN'S genus are the *Cyrtia exporrecta* and *C. trapezoidalis*, both of which are Silurian species. Since the genus was proposed, several other European fossils have been referred to it, and some American species have been added to the list.

As early as 1853, Mr. DAVIDSON, in his General Introduction to the Study of the Brachiopoda, had expressed some doubt as to the value of DALMAN'S Genus CYRTIA; but it was not till 1858 that he proposed the separation of certain species which had been referred to that genus, on the ground of a want of correspondence in their parts with the typical species of CYRTIA. These species, the *Cyrtia heteroclita*, *C. demarli* and *C. septosa*, were found not only to possess the high area with closed fissure, but also to show a peculiar modification of the dental plates of the ventral valve, and the shell-structure is likewise punctate; while in the types of DALMAN'S genus the shell is impunctate, and the dental plates are similar to those in SPIRIFER.

In CYRTINA, as described and illustrated by Mr. DAVIDSON, we have small spiriferoid shells with the valves very unequal, the ventral valve being extremely elevated and semipyramidal, with high area and narrow fissure closed by a convex pseudo-deltidium, presenting the same aspect with those heretofore referred to CYRTIA; the dental plates converge from the inner margins of the fissure, and uniting, form a single plate or septum which reaches to the bottom of the interal cavity, thus dividing it into two parts.

This arrangement leaves an enclosed triangular tube between the pseudo-deltidium and the converging dental plates. To these characters may be added the punctate texture of the shell, which, so far as now known, is accompanied in these forms by the external character and internal arrangements described.

Besides these features, several of our species have a median septum in the fissure, in continuation of the central septum below the junction of the dental plates. This septum is visible when the pseudo-deltidium is removed, as shown in figures of *C. rostrata**, and as seen in many specimens of *C. dalmani*, as well as in *C. biplicata* and in *C. hamiltonensis*. This central septum, both above and below the junction of the dental plates, may have the same origin : the coalescing of these plates allows the exterior laminæ of each to unite, and extending inward form the septum dividing the cavity; while the inner walls of the dental plates are united and recurved, turning outwards to form the septum dividing the triangular space beneath the pseudo-deltidium.

The several species which I have heretofore described as CYRTIA have all a punctate structure, and, so far as examined, they have the arrangement of the internal parts described in CYRTINA. It was not until after the completion of the third volume of the Palæontology of New-York in 1859, that I received that part of Mr. DAVIDSON's Monograph of the Carboniferous fossils containing his arguments for the separation of the genera and his description of CYRTINA. The characters of CYRTINA, as given by Mr. DAVIDSON, show its near relations with SPIRIFERINA; the principal differences, as illustrated in figures of the latter genus, being that the dental plates do not coalesce before reaching the bottom of the cavity, the high median septum rising unsupported nearly to the plane of the area.

In that volume I have described two species under the name of CYRTIA, both of which have the structure of CYRTINA; and in one of these I mentioned the discovery of the spires†, a feature which Mr. DAVIDSON had not

* Palæontology of New-York, Vol. iii, pl. 96, f. 2 *d*, 3 *a* & 4 *d*.

† *Cyrtia rostrata*, Pal. New-York, Vol. iii, p. 429.

observed at the time he published his description. In specimens of three species (*Cyrtina rostrata, C. hamiltonensis* and *C. dalmani*), the spires are oblique to the direction of the valves, their apices terminating in the rostral part of the ventral valve. This feature is likewise common to some species of SPIRIFERINA, as has been beautifully shown by M. E. DESLONGCHAMPS in his "*Etudes Critiques sur les Brachiopodes nouveaux ou peu connus*," in *S. rupestris, S. pinguis* and *S. hartmanni*. The form of the spirals is also more cylindrical than ordinarily observed in SPIRIFERA, and in this respect also resembling those of CYRTINA. The spiral coils in some species of SPIRIFERA are oblique to the axis of the shell, and this feature has been shown by Mr. DAVIDSON in *Spirifera bisulcata* (British Carb. Brachiopoda, Pl. vi, fig. 17), and by GEINITZ and GUTBIER in a species of SPIRIFERA referred to *S. cultrijugatus* of RŒMER.* So far as at present known to me, this genus does not extend below the horizon of the Niagara group.

In view of these facts, it becomes necessary to make the following corrections and references to previously described species.

Cyrtina pyramidalis.

Spirifer pyramidalis : HALL, Palæontology of New-York, Vol. ii, pa. 266, pl. 54, f. 7. 1852.

This species is from the shale of the Niagara group.

Cyrtina dalmani.

Cyrtia dalmani : HALL, Tenth Report on the State Cabinet, p. 64. 1857.

" " : IDEM, Palæontology of New-York, Vol. iii, pa. 206, pl. 24, f. 2.

From the shaly limestone of the Lower Helderberg group.

Cyrtina rostrata.

Cyrtia rostrata : HALL, Tenth Report on the State Cabinet, p. 64. 1857.

" " : IDEM, Palæontology New-York. Vol. iii, pa. 429, pl. 96, f. 1 – 6.

From the Oriskany sandstone.

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* Die Versteinerungen des Zechsteingebirges und Rothliegenden, oder des Permischen Systems in Sachsen : von HANNS BRUNO GEINITZ, Dr. Phil., und AUGUST VON GUTBIER, Konigl. Sachs.-Major. Heft I by Dr. H. B. GEINITZ, Tab. v, fig. 9.

Cyrtina biplicata.

PLATE XXVII.

Cyrtia biplicata : Hall, Tenth Report on the State Cabinet, p. 165. 1857.

Shell semipyramidal (semielliptical in the dorsal view); length and breadth about as two to three, with a height of area less than the length of the shell : hinge-line equal to the greatest width of the shell.

Ventral valve extremely elevated, semipyramidal, curving abruptly to the front and sides : the length from the apex to the cardinal extremity is often about the same as from the apex to the front of the shell. Mesial sinus somewhat deep, subangular in the bottom, and defined at the margins by a strong fold or plication : apex elevated, sometimes attenuate and slightly incurved over the high area, which is either flat or slightly arcuate; fissure narrow and partially or entirely closed by a convex pseudo-deltidium.

Dorsal valve depressed-convex, and sometimes nearly flat towards the cardinal extremities : mesial fold moderately elevated, and strongly defined by a furrow on each side; area extremely narrow.

Surface marked by numerous fine radiating striæ, and sometimes by distinct and even strongly marked imbricating lines of growth. The entire shell-structure is punctate.

Where the shell is preserved, the mesial sinus is bounded on each side by a distinct elevated fold having a depression on the outside of it, and this feature is often shown in the casts. The median septum extends for one-third or more of the length of the ventral valve, and its extension is shown in the fissure beneath the pseudo-deltidium. From the little that can be seen of the spire, in specimens examined, it is arranged as in Spirifera. In this example the spire may be displaced so as to appear in a transverse position. In two species where the position of the spires are clearly determinable, they are directed towards the apex of the ventral valve; but in these species the transverse extension is less than the elevation of the valve, and I can conceive it probable, that in species of the genus having a low area, with considerable lateral extension of the

valves, the spires may be directed towards the cardinal extremities as in SPIRIFERA.

The original specimen described was too imperfect to admit of a full description, but the characters indicated have been observed in all the specimens obtained.

The illustrations, Plate XXVII, figs. 5–10, represent the prevailing features of the species.

Geological formations and localities. This species occurs in the Schoharie grit, in Albany and Schoharie counties; and in the Corniferous limestone, at Williamsville in Erie county. I have also a specimen from the same rock in Michigan, received from Dr. ROMINGER of Ann-Arbor. Although having so wide a geographical range, this species is a rare fossil.

Cyrtina crassa (n. s.).

PLATE XXVII.

SHELL depressed-pyramidal (semielliptical in a dorsal view); length and breadth about as three to four; hinge-line equal to the greatest width of the shell, with the extremities slightly rounded.

VENTRAL valve depressed-semipyramidal, convex, regularly arching from the beak and cardinal area to the front; sinus broad and rounded in the bottom; beak extended and slightly incurved over the area, which has a height about equal to half the length of the valve.

DORSAL valve moderately convex, a little inflected or concave towards the cardinal extremities; mesial fold broad, moderately elevated, rounded above and strongly defined: area linear.

SURFACE marked on each side of the mesial fold and sinus by about four strong, low, rounded plications, which are crossed by fine threadlike concentric striæ and a few imbricating folds. Shell-structure punctate.

A single specimen only of this species has been seen; but its great lateral extension, comparatively low area, and few strong plications, preclude its union with any of the previously described species.

The figures 11 & 12 of Plate XXVII are a dorsal and ventral view of this species.

Geological formation and locality. In the Corniferous limestone, near Vienna, Ontario county.

Cyrtina hamiltonensis.

PLATES XXVII & XLIV.

Cyrtia hamiltonensis : Hall, Tenth Report on the State Cabinet, p. 166. 1857.
" " . : Billings, Devonian Fossils of Canada West (Canadian Journal), p. 263. 1861.
Compare *Cyrtia acutirostra*, Shumard, Geol. Report Missouri, Part i, pa. 204, pl. c, f. 3. 1854.

Shell more or less triangular-subpyramidal; hinge-line equal to the greatest width of the shell; proportions of length, breadth and height variable, but frequently the width is equal to the length of the ventral valve, and the height of area is equal to the length of the dorsal valve: surface plicate.

Ventral valve quadrilateral in outline, obliquely subpyramidal, most prominent at the beak, which is very variable in elevation and straight or a little arched over the area, and not unfrequently attenuate and distorted or turned to one side; mesial sinus wide and strongly defined, rounded or subangular in the bottom: area variable, large and elevated, plane or arcuate in different degrees with the lateral margins angular, distinctly striate in both directions; fissure narrow, closed by a convex pseudo-deltidium, which is perforated above by an oval or narrowly ovate foramen.

Dorsal valve depressed-convex, with a broad more or less prominent mesial fold, which is bounded by broader furrows than those between the plications, and is sometimes extremely elevated in front; beak scarcely rising above the hinge-line: area narrow linear, but quite distinct.

Surface marked by about six to eight (rarely one or two more) simple rounded plications on either side of the mesial fold and sinus, and these are crossed by very fine concentric lines of growth, which at intervals become crowded and subimbricate, especially towards the margins of older shells. The finer surface-marking is minutely granulose or papillose, and the shell-structure distinctly punctate. In some of the larger individuals there is an obscure elevation on each slope of the sinus, resembling an obsolete plication.

The longitudinal median septum extends for more than half the length of the ventral valve, and is continued into the cavity beneath the pseudo-

deltidium. These features are shown in the casts and in transvers sections of the valve. The dorsal valve shows a double or bilobed cardinal process, with the strong crural bases supporting spiral arms, which are directed into the two compartments of the ventral valve, and, making numerous turns, terminate in the rostral part of the shell.

I have heretofore compared this species with *Cyrtina heteroclita* (= *Calceola heteroclita*, DEFRANCE; *Spirifera heteroclita*, VON BUCH, &c.); but in that one the plications are described as angular, and generally less numerous than in ours; though the variety *multiplicata*, DAVIDSON, has more numerous plications; and this, with other characters, shows that the fossil undergoes variations similar to our own, and that it is a closely allied form holding a similar geological position.

The specimens in the Hamilton group of New-York are usually small, measuring about half an inch in length and breadth; the largest one seen by me being a little more than $\frac{11}{16}$ of an inch in width, and about $\frac{11}{16}$ in length from the apex to the front of the valve. In some Canadian specimens, the length and width are about $\frac{7}{8}$ of an inch. The species has a wide geographical and considerable vertical range; being known in the Schoharie grit (Plate XXVII, f. 1, 2 & 13), Corniferous limestone, Hamilton and Chemung groups.

Figures 3 and 4 of Plate XXVII are from the Corniferous limestone of New York.

I am indebted to Dr. JAMES KNAPP of Louisville, Kentucky, for the specimen illustrating the spires, which is figured on Plate XLIV, fig. 50. This one is from the Corniferous limestone, and presents six or seven turns of the spire; while some specimens from the Hamilton group have shown, on being cut through, ten or eleven turns of the spire.

The figures 26 – 33, Plate XLIV, present the usual aspect of the species in the Hamilton group in New-York, while 37 – 40 are of a larger individual.

Figures 34 – 36 are of a variety where the area is flat, and the plications more angular than usual.

Figures 41 & 42 are of a large individual from the Hamilton shales of Canada West.

Figure 51 is of a specimen of this species from the Hamilton group of Iowa, received from Mr. O. ST.JOHN; and I have similar forms from near Iowa city.

The transverse and longitudinal sections, showing the interior structure, are of specimens from the Hamilton shales of Canada West.

Geological formations and localities. This species occurs in the Schoharie grit, in Albany and Schoharie counties, and in the Corniferous limestone of Eastern and Central New-York, and at St.Marys and Cayuga in Canada West. In the Hamilton group, it occurs on the shores of Cayuga, Seneca and Canandaigua lakes, at Moscow, York, Darien, Hamburgh and Eighteen-mile creek in New-York; near Cumberland in Maryland; abundantly at Widder station in Canada West; at Independence, Rockford and Waterloo in Iowa.

I n the Chemung group, the var. *recta* occurs at Philipsburgh in Allegany co.

Cyrtina hamiltonensis, var. recta.

PLATE XLIV.

Figures 36 an d37 of Plate XVII illustrate this form, which has a plane flat area, without incurvation of the beak, and with angular plications.

This form is not uncommon in the Hamilton group, and was for a long time the only one known to me in the Chemung group; but very recently I have received, among a collection of *Spirifera disjuncta* from the southern part of the State, a specimen which indicates that the species may have in this horizon the same variations which it has in the formation below.

Cyrtina curvilineata [?]

PLATE XLIV.

Compare *Cyrtia curvilineata*, WHITE: Proceedings of the Boston Society of Nat. History, Vol. ix, p. 25.

SHELL rather large, obliquely subpyramidal: hinge-line equalling or slightly less than the greatest width of the shell; length of dorsal valve less than its width, and one-third greater than the height of area of the ventral valve. Entire surface plicate.

VENTRAL valve obliquely subquadrilateral in outline, the apex turned to the left: area much elevated, inclined backwards, slightly incurved. The fissure has apparently been closed in the lower part, but the pseudo-deltidium is broken away, and there is no evidence that the upper two-thirds of the fissure has been closed at any recent period of the animal's life.

DORSAL valve semielliptical, convex in the middle and flattened at the cardinal margins; mesial fold prominent towards the front.

SURFACE marked by about twelve or thirteen rounded plications on either side of the mesial fold and sinus. The mesial fold has four or five low rounded plications near the front, while there are four corresponding folds on the sinus.

This species has the general form and proportions of the *C. hamiltonensis*, and occurs with that species in rocks of the age of the Hamilton group in the west. It differs slightly in some of its proportions from the prevailing eastern forms of that species, but not more than is observed among specimens of the same in collections from New-York, Canada West, and the Western States. The distinguishing feature is in the presence of plications on the mesial fold and sinus. The presence

or absence of a pseudo-deltidium covering the fissure I should not regard as of specific importance, and the distortion of the beak of the ventral valve is a feature common also to the *C. hamiltonensis*.

This species is probably the one described by Dr. WHITE; but he speaks of the shell as small, while the one under examination is large for one of the genus. It has also a greater number of plications, both on the fold and sinus as well as on the sides of the shell. These differences may be due to age and condition.

The figures 53–55, Plate 44, illustrate the characters of this species. The sinus is unequal in depth, but its limits are not quite sufficiently defined in the figure, and I have added a dotted line (....s) beneath, indicating the limit of the sinus on the right side.

Geological formation and locality. In beds of the age of the Hamilton group near Iowa city, Iowa.

GENUS TREMATOSPIRA.

Trematospira: HALL, in Third volume of Pal. New-York, p. 207.
" " in Twelfth Report on the State Cabinet, p. 27. 1859.*

THIS genus was originally proposed by me to embrace a few forms, having a general resemblance to SPIRIFERA, but without the extended hinge-line and area; or with the latter feature uncertain or undefined, and wanting in the characters of a true area. Such at least is the character of the specimens originally examined; some of which approach in extended form to RHYNCHONELLA.

Up to this time, comparatively few species are known; and of the greater part of these, few individuals have been obtained, so that our knowledge of the interior structure is still imperfect. In all the species possessing the peculiarities of external form noticed, we find a punctate structure of the shell; a character which alone is sufficient to separate them from SPIRIFERA proper, or from RHYNCHONELLA.

The genus was founded originally upon species from the Lower Helderberg group of New-York, including a single species from the Niagara group. I have, since that time, observed similar external features in specimens from the Lower Silurian rocks of Ohio and elsewhere; while a single species from the Hamilton group, first described by me as *Atrypa*

*The description of this and other genera of Brachiopoda, printed in Vol. iii, Palæontology of New-York, in the years 1857 and 1858, were first published in the Twelfth Report on the State Cabinet in 1859.

hirsuta, has been found to have a punctate structure, with spires arranged as in SPIRIFERA, and otherwise possessing the characters of TREMATOSPIRA; and another species from the group has been added to the number.

Desirous of avoiding too great a multiplication of genera, I at first included under this designation species which it has since been found necessary to separate on account of marked difference in form, and also in the character of the hinge appendages. These latter species, under the name of RHYNCHOSPIRA, seem to me sufficiently distinct from RETZIA to be recognized at least as a subgenus.

In the present state of our knowledge of the heterogeneous assemblage of material known under the name RETZIA, it is quite impossible to define the limits of that genus with any precision. Farther investigations, with better material, are required for this purpose; for the determination by external form alone is not satisfactory. In the mean time, I refer the following forms to the genera under which they are placed according to the best information we have been able to obtain of their structure and affinities.

Trematospira gibbosa.

PLATE XLV.

Trematospira gibbosa : HALL, In Thirteenth Report on the State Cabinet, p. 82. 1860.
Retzia eugenia [?] BILLINGS, Canadian Journal, p. 147. 1861.

SHELL more or less gibbous : valves subequally convex, transversely subelliptical, about once and a half as wide as long; hinge-line less than the width of the shell; strongly plicate.

VENTRAL valve less gibbous than the opposite, somewhat abruptly arcuate towards the apex, which is truncated by a circular foramen : this is completed on the inner side by what appear to be depressed deltidial plates, which at the same time form a flattened triangular space or false area. Mesial sinus abruptly depressed in old shells, and less conspicuously in younger ones.

Dorsal valve gibbous, more convex than the opposite : beak abruptly incurved, and concealed within the cavity of the ventral valve. Mesial fold more or less conspicuous, sometimes scarcely raised above the adjacent plications.

Surface marked by nine or ten strong angular plications : three of these, in the centre of the dorsal valve, are more approximate and smaller than the others, giving the character of a mesial fold which is sometimes scarcely elevated above the general contour of the surface; while the two central plications on the opposite valve are much smaller than the adjacent ones, and abruptly depressed. The concentric lamellæ of growth, in crossing the plications, give a series of zigzag lines; and these often become crowded and very conspicuous on the front of the shell. Entire surface finely granulose, and the shell structure punctate.

The interior of the dorsal valve shows a bilobed cardinal process, with obscure indications of the crural bases. There is a distinct mesial septum in the upper part of the valve. The muscular impressions have not been satisfactorily observed.

The largest specimens of this species are about half an inch long and five-eighths of an inch wide, while the depth in gibbous specimens is little less than the length.

This shell has much the appearance of a broad gibbous Rhynchonella; but the perforated beak, false area and punctate structure, serve to distinguish it from that genus. I have referred this shell to Trematospira, from the generally similar character of the beak and perforation, and the punctate structure of the shell. I have not discovered the existence of spires; but my specimens are too few to admit of the necessary examinations.

Geological formation and localities. This fossil has been found near Bellona, Ontario county; near Geneseo and York, Livingston county; and at Pavilion and Darien in Genesee county, New-York.

Trematospira hirsuta.

PLATE XLV.

Atrypa hirsuta : Hall, in Tenth Report on the State Cabinet, p. 108. 1857.
Trematospira hirsuta : Id. Thirteenth Report on the State Cabinet, p. 101. 1860.
Athyris (?) *chloe* : Billings, Canadian Journal, p. 282. 1860.

Shell depressed-orbicular in the young state; becoming subtrilobate by the gradual development of a mesial fold and sinus, and often gibbous in the older specimens; valves subequally convex; hinge-line extending about two-thirds the width of the shell.

Ventral valve usually a little more gibbous than the opposite; greatest convexity above the middle of the shell, whence it curves regularly to the apex, which is terminated by a circular foramen, or more often truncated below by the summit of the opposite valve: contour regularly curving to the cardinal and lateral margins. The mesial sinus becomes gradually developed above the middle in full grown shells, and is very conspicuous towards the front, having the sides curving and rarely strongly defined. The false area is not visible beneath the beak.

Dorsal valve regularly convex in young shells; becoming elevated in the centre, and a mesial fold gradually developing itself, till in old shells it becomes very conspicuous towards the front. The sides are pretty regularly convex, and curving towards the margins.

Surface marked by from thirty to forty simple low rounded striæ, which are obscure towards the beaks, but become larger and more conspicuous towards the margin: these are crossed by fine close concentric lines of growth, and more distant imbricating lamellæ. The surface ordinarily preserved is granulose; but when perfect, it is covered by minute seta or spinules, the bases of which, remaining, give the papillose character. Entire shell structure punctate.

The interior of the ventral valve shows two strong teeth, which are extended in low plates along the sides of the rostral cavity to the margins of the muscular area, which is broad, flabelliform, and scarcely defined on the front and lower lateral margins.

The interior of the dorsal valve shows a strong deeply bilobed cardinal process, with the bases of slender crura; the teeth sockets are large and deep; there is a low median crest or septum, which is somewhat strong above, but dies out about the middle of the shell. In specimens which have been cut to show the spires, these appendages are slender, with about ten or eleven turns on each side.

The proportions of length and breadth are about as three to four. The largest specimen observed is a little more than three-fourths of an inch in length, by an inch and one-sixteenth in width; while many of the specimens are less than half these dimensions. A well-formed specimen of about three-fourths of an inch in length by one inch, has a depth of nine-sixteenths of an inch. A very gibbous specimen measures three-eighths of an inch in length, nine-sixteenths in width, and half an inch in depth.

The general aspect of this shell is similar to *T. multistriata;* but the form is usually less gibbous, the sinus more distinctly defined, and the striæ are essentially simple. It is distinguished externally from ATRYPA, by the granulose surface and punctate character of the shell.

This fossil is not abundant, though not exceedingly rare. It is principally restricted to the western part of New-York, and has been found in Canada West.

TREMATOSPIRA HIRSUTA (Hamilton group).

7 8 9 10

FIGS. 7 & 8. Dorsal and front views of a specimen.
FIGS. 9 & 10. Interior of the dorsal and ventral valves.

Geological formation and localities. This species occurs on the shores of Canandaigua lake and at Bloomfield, Ontario county; at York and Moscow, Livingston county; at Pavilion and Darien, Genesee county, and at Eighteen-mile creek in Erie county, New-York. In Canada West it occurs near Widder station on the Grand Trunk railway.

I have received this species from Dr. JAMES KNAPP, of Louisville, collected from the corniferous limestone at the Falls of the Ohio.

The following figures in wood are illustrations of some of the typical species of TREMATOSPIRA, from the Lower Helderberg group, described, and heretofore given in the State Cabinet Report.

TREMATOSPIRA MULTISTRIATA.

1 2 3

FIGS. 1 & 2. Ventral and front views.

FIG. 3. The interior of a ventral valve filled with stony matter, and ground so as to show the spires

4 5 6

FIG. 4. TREMATOSPIRA PERFORATA. The upper part of the shell enlarged, showing beak of ventral valve, perforation and triangular space below.

FIGS. 5 & 6. TREMATOSPIRA COSTATA. Dorsal and front views of a specimen.

GENUS RHYNCHOSPIRA (HALL).

In the third volume of the Palæontology of New-York (page 213), I suggested this name as a subgenus of TREMATOSPIRA; but subsequently, from certain peculiarities of hinge-structure, general form, etc., I was induced to propose it as a distinct genus. Although approaching the typical species of RETZIA, I am not satisfied of the identity of the two; and until we have better information regarding the latter genus, I propose to place under RHYNCHOSPIRA those forms which are similar to *R. formosa* of the Lower Helderburg group.*

Rhynchospira lepida.

PLATE XLV.

Rhynchospira lepida : HALL, Thirteenth Report on the State Cabinet, p. 83. 1860.

SHELL small, broadly suboval, with the valves subequally convex, and the beak of the ventral valve extended.

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* In the Sixteenth Report upon the State Cabinet of Natural History, pp. 53–59, I have discussed the relations of RETZIA, TREMATOSPIRA, RHYNCHOSPIRA, with the materials at that time accessible to me.

VENTRAL valve broadly suboval, regularly convex, or with a scarcely perceptible mesial depression. The beak is much elevated above the opposite valve, gently arcuate, with the apex perforated, and the space between it and the summit of the dorsal valve closed by two convex deltidial plates which are excavated on their inner and upper margins, forming an elongate oval perforation communicating above with the opening of the beak.

DORSAL valve often nearly as wide as long, moderately convex, with the greatest convexity a little above the centre. There is a slight depression along the middle in some individuals, but this is an obscure or inconstant feature.

SURFACE marked by about twenty-four (varying from 20 to 25) simple regular plications, which are gradually enlarged towards the margins of the valve. On the dorsal valve, two or three of the central plications are depressed, causing a slight sinus in front; but there is no corresponding elevation on the opposite valve. The shell structure is punctate throughout.

The interior structure is not known.

I have referred this species to RHYNCHOSPIRA, from its generally similar aspect to those of the Lower Helderberg group; but the large deltidial plates and double perforation have not been observed in those species; though in *T. rectirostra*, there are deltidial plates closing the space below the apicial foramen. It is still desirable to examine specimens for the presence of the spires or crura, as these are unknown.

The prevailing form of the specimens is that described; but rarely there occurs one that is more elongated. The species has the general aspect of RHYNCHONELLA; but it is readily distinguished by the narrow depression of two plications on the dorsal valve, and by the punctate structure of the shell, as well as by the foramen and deltidial plates when these features are preserved or exposed.

Geological formation and localities. In the shales of the Hamilton group, on the shore of Canandaigua lake, and near Bellona, in Ontario county, New-York.

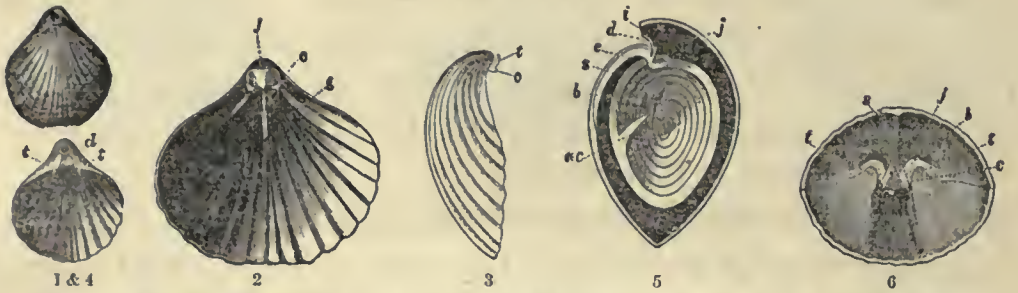
RHYNCHOSPIRA NOBILIS.

Rhynchospira nobilis : HALL, Thirteenth Report on the State Cabinet, p. 83. 1860.

A re-examination of the specimens has left some doubt regarding the generic relations of this fossil, and the description is deferred to another part of the volume.

The following figures are illustrations of one of the typical species of Rhynchospira, from the Lower Helderberg group.

Rhynchospira formosa.



1 & 4 2 3 5 6

Fig. 1. Dorsal view, natural size. Fig. 2. Interior of a dorsal valve, showing the cardinal process, etc.
Fig. 3. Profile of figure 2, showing the recurved cardinal process.
Fig. 4. The ventral valve of the same species.
Fig. 5. A longitudinal section, showing the articulation of the valves, the origin of one of the crura, the spire, etc.
Fig. 6. The upper part of two valves, showing the mode of articulation.

Genus Nucleospira* (Hall).

This genus was proposed by me to include a few small species of fossils which had heretofore been referred to Spirifer, Atrypa, Orthis, etc., but which do not possess the true characters of either of these genera. Since we know the peculiarities of its internal structure and the accompanying exterior, together with the punctate texture, there is no longer any difficulty in recognising these shells among the other Brachiopoda.

The following are the important characters of the genus, as determined from the examination of the species of the Niagara, Lower Helderberg and Hamilton groups.

Shell depressed spheroidal or transversely elliptical, more or less gibbous or ventricose, furnished with internal spires as in Spirifera; hinge-line shorter than the width of the shell; cardinal extremities rounded: valves subequal, articulating by teeth and sockets. Ventral valve having the beak slightly extended beyond the opposite valve, and beneath it a triangular depression or area, which has sometimes a shallow semispoonshaped form; on each side of which, at the base, is a strong tooth. A narrow ridge or septum along the centre of the inner

* This genus was first described in the third volume of the Palæontology of New-York, p. 219, and is copied on pages 24 and 25 of the Twelfth Report on the State Cabinet.

side of the valve often extends from beak to base. Dorsal valve furnished with a strong spatulate cardinal process, which, rising vertically from the cardinal margin, is closely grasped at its base by the cardinal teeth of the other valve; and thence bending abruptly upwards, and expanding, is projected into the cavity of the opposite beak, lying close upon the underside of the false area. This process is grooved or depressed in the centre of the upper side, so as to leave between it and the arch of the ventral beak a narrow space for the passage of a pedicle, a minute foramen being sometimes observed in the beak for its protrusion. From the sides of this process, above the junction of the teeth of the opposite valve, and at the point where it bends upwards, originate the crural processes which support the spires. A deep cavity beneath the cardinal process extends to the dorsal beak, where originates a thin elevated septum often extending to the base of the shell. Muscular impressions of the dorsal valve occupy a narrow oval space; those of the ventral valve broader, flabelliform.

Under this genus I have described *N. ventricosa*, *N. elegans* and *N. concentrica* from the Lower Helderberg rocks; *N. pisiformis* (*Orthis pisum*, Pal. New-York, Vol. ii, p. 450), from the Niagara group; and *N. concinna* (*Atrypa concinna*, Rep. of the Fourth Geol. District of New-York, 1843, p. 200, f. 3), which are the species known to me at the beginning of 1858.

Nucleospira concinna.

PLATE XIV.

Atrypa concinna : Hall, Geological Report Fourth District New-York, p. 200, f. 3. 1843.
Nucleospira concinna : Hall, Twelfth Report on the State Cabinet, p. 25 and p. 26. 1859.

Shell depressed, subspheroidal, nearly circular in outline, the width being usually a little greater than the length; valves subequal.

Ventral valve regularly convex, the greatest convexity a little above the middle, and curving regularly to the sides and front; umbo prominent, the beak neatly pointed and incurved over the apex of the dorsal valve, leaving a space between which sometimes exposes the narrow area. There is usually a narrow depressed line from the beak to the base of the valve; but this is sometimes partially absent, or so faint as not to be readily observed.

Dorsal valve regularly convex, sometimes gibbous, becoming a little depressed towards the base, the greatest convexity being a little above the centre: there is usually a depressed line along the middle of the valve. The hinge-line is about one-third, and sometimes half as long as the width of the shell.

Surface usually smooth or very finely papillose; but in its perfect condition, it is covered by numerous fine seta which are matted together, and the interstices being filled with clay, it has a rough appearance; while under a lens, these seta give a finely striate aspect. Beneath the fine papillose surface, the texture of the shell is minutely punctate.

The interior of the ventral valve presents beneath the beak a low depressed area, or false area, which is bordered on each side by a strong tooth. The muscular area is somewhat broad, flabelliform, with the margins lobed; the occlusor imprints in the centre are strongly marked elongate oval spots, and there is a low median crest which often extends to near the front of the shell. In the dorsal valve there is a strong wide cardinal process, the inner face of which is mainly occupied by a broad oval pad for the muscular attachment (see figure, Plate 45), extending in a narrow callosity into the cavity below.

The teeth sockets are deep, and margined by a strong callosity which forms the base of the process; and from thence proceed the crura and the slender spiral arms, which make about eleven or twelve turns in the larger individuals. The muscular area is narrow, well defined, and lobed below; while the inner portions, marked by the occlusor muscles, are two sublinear spots. A slender crest extends along the middle of the impression. The interior of the shell is somewhat pustulose.

The figures given exhibit the variations in size and proportions usually observed among large collections of specimens.

Figure 33 is a cast from the Schoharie grit.

Figures 34 and 35 are from the Corniferous limestone; and the succeeding figures are of Hamilton group specimens.

The hinge-line of the two valves has been greatly enlarged, to show the parts described; and the casts of both valves have been enlarged two diameters, to show the character and form of the muscular impressions.

Geological formation and localities. This species is known in the Schoharie grit, in Albany and Schoharie counties; in the Corniferous limestone at Lapham's mill in Ontario county, at Caledonia in Livingston county, and at Williamsville in Erie county, New-York, and Falls of the Ohio; and in the Hamilton group, in the vicinity of Apulia in Onondaga county, shores of Seneca and Cayuga lakes, Canandaigua lake, Genesco, York, Moscow, Pavilion, Alexander, Darien, Hamburgh, Eighteen-mile creek, and other localities in the western part of the State of New-York.

I have received very fine specimens of the internal casts of this species from Dr. G. A. Williams, collected in the Hamilton group of Hardy county, Va.; and it likewise occurs near Cumberland, Maryland.

Note. In the arrangement of the preceding genera of the Family Spiriferidæ, I have followed what appeared to be the most natural order; and since we pass almost insensibly from Spirifera to Spiriferina and Cyrtina, it is scarcely possible, from what we know, to remove the Genus Trematospira from the relation in which I have placed it. The Genus or Subgenus Rhynchospira will therefore follow, and all those forms referred to the Genus Retzia will come into the same relation. I have placed in this association the Genus Nucleospira, which may, perhaps, be more nearly related to the following than to the preceding genera. So far as we know, the structure of the spire (though with some variations) is similar in all these, and the presence of an area or false area may be recognized in all or nearly all of them.

By this arrangement the Genera Atrhyris, Merista and Meristella, will be farther removed from Spirifera proper, while it might appear that their relation would be more nearly with the smooth Spirifers. I have followed this order of arrangement, beginning with the Genus Atrhyris, because I had so arranged the matter and the plates of the volume before having made the final studies of the interior and the determination of the structure of the spires. It will be seen, however, that the spires in Meristella are very nearly like those of Spirifera proper, while those of Atrhyris show a wide departure in the character of the loop and intercalated lamellæ. Regarding the Genus Meristella in all its characters as now determined, I would place it before Atrhyris in its relation to Spirifera.

Genus Athyris (McCoy).

Athyris, McCoy, 1844. *Spirigera*, D'Orbigny, 1847.

The Genus Athyris was established in 1844 by Prof. McCoy, upon certain species separated from the Terebratulæ; and when restricted according to the original types of that author, includes a very natural group of shells, but which nevertheless possess many external features in common with the later established genera Merista and Meristella, and from which the species are distinguished by important internal characters.

The shells of the genus are variable in form, being suborbicular, transverse or elongate, subglobose or depressed, and sometimes subangular. The typical species are depressed suborbicular. The structure of the shell is fibrous; the surface in most species is strongly marked by concentric striæ, and some of them are strongly lamellose, with the lamellæ becoming fimbriate or pectinate. In this aspect, as well as in general form, these shells have a resemblance to some of the Spirifers with short area and rounded cardinal extremities. The surfaces are sometimes indistinctly radiatingly striated; but these striæ are usually subordinate to the concentric striæ or lines of growth; and it may be doubtful whether any well authenticated species of the genus has conspicuous radiating striæ or costæ.

The apex of the ventral valve is usually or perhaps always perforated by a rounded foramen, the lower side of which is formed by the umbo of the opposite valve. When the valves are separated, this foramen communicates with a triangular space, which opens into the main cavity of the valve. This triangular fissure, which in older shells is usually occupied by the beak of the opposite valve, has at some time during the animal's life been closed by deltidial plates.

The dorsal valve is furnished with a strong cardinal process, the centre of which is often depressed and spoon-shaped, but sometimes thick-

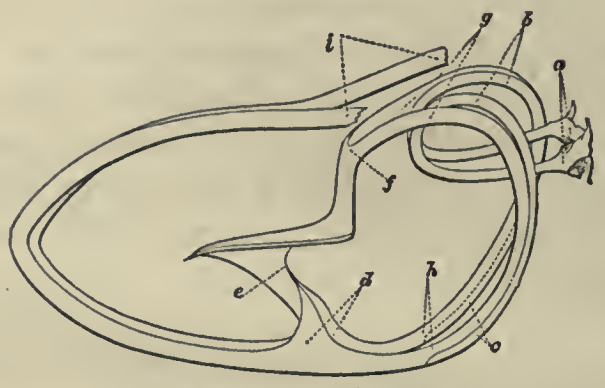
ened and convex. The crura proceed from each side of this plate anteriorly; while the posterior and lateral margins become more or less thickened, or elevated into ridges bordering the teeth-sockets.

The muscular area is somewhat variable in form; but in the ventral valve it is oval or ovate, more or less flabelliform. The occlusor muscular imprints are marked upon the shell, and upon the cast, by a narrow elongate scar; while the divaricator muscles occupy a wider space on each side, and are usually strongly striated. In the dorsal valve the muscular area is narrow, and often divided by a low longitudinal crest or septum. The area outside of the muscular scars is papillose or papillose-striate, and often beautifully marked by vascular impressions. The spires are complicated by intermediate lamellæ.

The European species of ATHYRIS (*A. pectinifera*, *A. roissyi* and *A. concentrica*), as shown by WOODWARD, DAVIDSON and others, have the spires complicated by accessary lamellæ, which, rising from the connecting loop, are intercalated between the first and second turns of the normal lamellæ, and have their extremities free.

Although the presence of spires has been long known in the American species, I believe no one has hitherto shown their analogy with the European forms. In the determination of our species, however, and their relations with MERISTELLA, it became necessary to make a careful study of all the internal characters upon which generic and specific distinctions might be founded; but since all the specimens were essentially solid, it has been a labor of no little difficulty to determine accurately the true character of these internal appendages. By carefully cutting down specimens of *A. spiriferoides*, which is very similar to the *A. concentrica* of Europe, the disposition of the spiral lamellæ has been found as shown in the following diagram, which represents only the central portion of the spirals to the end of the first volution.

ATHYRIS SPIRIFEROIDES.



Central portion of the spires.*

The origin of the crura, or point of attachment to the hinge-plate, is indicated in the figure at *a*, from which the two lamellæ proceed for a short distance in a nearly direct line forward, but are soon bent upwards and recurved upon themselves as shown in the figure at *b*, whence they are again bent downwards into the cavity of the dorsal valve. From this point the lamellæ follow very nearly a direction parallel to the external contour of the shell, being the exterior bands indicated by the dotted lines to *c*. Farther on, these become expanded and send off from each one a projecting process at *d*, and thence are united in a solid plate at *c*, forming the loop which connects the two parts of the spiral arms. It will also be observed that the lamellæ are twisted, the exterior part at *d* becoming the interior at the point of junction of the two parts. This plate, formed by the junction of the lamellæ, is sharply bent backwards almost in the plane of the longitudinal axis of the shell; and thence rising nearly at right angles, becomes bifurcated at *f*, giving origin to the accessary lamellæ *g*, which are recurved in a plane essentially parallel to the first volution of the spire, and coalesce with it at the points indicated by the dotted lines *h*, thus acting as an additional support to the

*I am indebted to the rare mechanical skill and artistic manipulation of Mr. R. P. WHITFIELD for the preparation of specimens illustrative of this and another species of ATHYRIS, as well as of the spires of MERISTELLA, etc.

primary lamellæ of the spire in its first volution.* The lamellæ are represented as cut away at *i*, showing but a single volution. The remaining portions of the spires consist of simple volutions arranged in a conical form.

Athyris spiriferoides.

PLATE XLVI.

Terebratula spiriferoides : Eaton, American Journal of Science, Vol. xxi, p. 137. 1831.
" " Id. Geol. Text Book, p. 46. 1832.
Atrypa concentrica : Conrad, Annual Report on Pal. New-York, pp. 111, 112. 1838.
" " Hall, Report on Fourth Geol. District New-York, p. 198, f. 5. 1843.
Spirigera spiriferoides : (Eaton, sp.), Hall in Tenth Report on the State Cabinet, p. 153. 1857.
? *Terebratula concentrica* : Von Buch, Ueber Terebratula, T. 103, Berlin, 1834. Mem. Soc. Geol. France, Vol. iii, p. 214. 1839.
Spirigera concentrica : Billings, Canadian Jour. 1861, and Geology of Canada. 1863.

Shell varying from transversely oval to suborbicular and sometimes subquadrate, depressed or subglobose, more or less deeply sinuate on the ventral side, with a corresponding elevation on the dorsal side: hinge-line short; the cardinal extremities rounded.

Ventral valve moderately gibbous, often regularly convex above the middle, and becoming deeply sinuate towards the front, which is frequently abruptly elevated, flattened or a little concave towards the cardinal extremities in the wider specimens: umbo gibbous, the beak incurved, and often directed in a line nearly rectangular to the plane of the longitudinal axis, and covering the umbo of the opposite valve; apex perforate.

Dorsal valve gibbous, much more convex than the opposite valve; umbo prominent, outline regularly convex above the middle and curving

* Although expressing no doubt regarding the investigations of European species which have shown the free termination of the accessary lamellæ, it seems to me more natural and as serving a practical purpose in the economy of the animal, to have them attached to the primary lamellæ of the spires for the purposes of support and strength. It should not be forgotten, however, that the accessary lamellæ are very slender near their point of junction, and may be easily separated or broken, and it requires the greatest caution to preserve them entire. In specimens where these appendages are exposed from natural causes, the chances would be much against their preservation entire.

abruptly to the sides: the usually undefined mesial fold becomes visible below the middle of the valve, and usually very conspicuous towards the front, which is abruptly elevated.

Surface marked by concentric lines of growth, and the lamellæ often extending and closely imbricated; fine interrupted and scarcely distinct radiating striæ, which appear like ducts within the substance of the shell, mark the surface in many specimens. The upper part of the shell is sometimes nearly free from imbricating lamellæ, but they become crowded towards the front.

The interior of the ventral valve shows two strong teeth at the base of the foramen, extending in strong plates to the base of the rostral cavity, which is distinctly hollowed out for the reception of the pedicle. The muscular impressions begin just at the base of the rostral cavity, and continue to a little below the middle of the length of the valve, as shown in fig. 27. These features are impressed upon the cast, as shown in figures 29 and 30; and the surfaces outside the muscular impression are often beautifully and variously marked by vascular impressions which are numerously ramified towards the margin, as shown in figure 30. This character is often more extreme, and the ramifications are at least twice as numerous as in this figure; a feature more faintly shown in the lower part of figure 29.

The interior of the dorsal valve is furnished with a strong cardinal process, the centre of which is often depressed and somewhat spoon-shaped, but frequently thickened: it is bounded posteriorly by elevated socket-margins, and the crural bases diverge from either side of the anterior portion. The muscular impression is narrow elliptical, and divided by a low median crest. These features are shown in figure 26; and the reverse or impression is well preserved in figure 28, which is a cast of the interior of another dorsal valve.

The internal spires are often well preserved, and show about fifteen turns: the two bands are connected at a point about half the length of the shell from their commencement, by a sharply arched loop, in the manner shown in the illustration given, and which is indicated in fig. 31.

From this loop on the ventral side there is a bifurcation, from which proceed accessary lamellæ which are intercalated between the first and second turns of the spire, as shown in the illustration under the generic description.

The figures on Plate 46 present the principal varieties in form known to me in the Hamilton group. The young individuals in this formation are usually pretty symmetrical, as shown in figure 5. They are generally not strongly lamellose, but sometimes acquire this character before attaining their full size, as shown in figures 6, 7 and 10.

In figure 8 we have an extremely oblate form, where the width is much greater than the length; and figure 9 shows a subquadrate regular form. We have similar extremes in figures 11 and 12, where the first is a little longer than wide; and the second, having the same length, has a much greater width and less depth. These figures illustrate the extremes of form among the young and half grown individuals; while the full grown specimens of the oblate form are shown in figures 13 and 14.

Figures 15 – 19 illustrate the larger or apparently full grown forms of moderate gibbosity ; while figures 20 – 24 are of the more gibbous forms. Since these varieties of form occur in the same localities, both being quite common, it is possible that they may indicate sexual differences.

Figure 25 is an extremely large form of moderate convexity and closely lamellose surface.

The casts present equally great extremes in form and proportions ; and the muscular and other interior markings are subject to slight variation.

The dimensions of this shell vary, from specimens much smaller than figure 5 and having a length of a quarter of an inch, to those having a length of about 20 lines with a width of 22 lines, while the depth is less than 10 lines, or about the same as that of figures 22 and 23.

After an examination of many hundreds of specimens, showing all the extremes of form and character, I can find no means of specific distinction among them.

I have heretofore expressed an opinion that this species is distinct from the *Athyris concentrica* of Europe, judging from the more straight hinge-line and less prominent beak of the ventral valve, as well as that the greatest breadth is above the middle of the shell. In the European species also, according to figures and specimens, the ventral valve is always proportionally a little more convex than in the American specimens. I have scarcely seen any illustration of the interior of European specimens; but the cast of a dorsal valve given by Mr. Davidson in his Monograph of British Devonian Brachiopoda shows a comparatively narrower and more elongate muscular area, a form not approached in any degree by the

numerous casts in my collection. Mr. DAVIDSON says: "No defined septum is "observable in this [the dorsal] valve, but a rudimentary mesial ridge divides "the quadruple impressions of the adductor." In the "ventral valve the dental "plates are tolerably developed; while the adductor leaves a small oval scar "towards the middle of the valves, and which scar is separated into two parts by "a minute mesial elevation, under and outside of which are seen the large impres-"sions of the divaricator muscle."

In our specimens there is a thin defined septum in the dorsal valve, reaching from the apex for more than half the length of the shell; and in the ventral valve the dental plates are rather strongly developed, while the lower margin of the adductor impression is considerably above the middle. These differences, therefore, do not serve to change the opinion already expressed, and I shall retain for the present the name originally proposed by EATON; more especially since it has priority in point of time.

The *A. concentrica* is a characteristic fossil of the Upper Devonian strata of Europe, but Mr. DAVIDSON remarks that it is not very common in Great Britain; and he says he has not seen it from the Middle Devonian of Newton and Ogwell in Devonshire, whence it has been cited by Mr. MORRIS in his Catalogue; which would leave us to infer that it is not common in that position. Our species begins its existence at the epoch of the Corniferous limestone, and is abundant in the Hamilton group, but I do not know of its occurrence in the Chemung group. It must rank, therefore, rather as a Lower than an Upper Devonian species in America.

Geological formations and localities. This species occurs in the Corniferous limestone in Albany and Schoharie counties, and rarely in the same rocks in the western part of the State. It is common in the Hamilton group, along Cayuga lake, and at localities east of that line, though more often occurring as partial casts. It is likewise common on the shores of Seneca and Canandaigua lakes, in the Genesee valley at several localities, at Darien, Hamburgh and Eighteen-mile creek, being more abundant in the latter place than any other locality known to me. It occurs at Widder station and Bosanquet in Canada West, in the same position. It likewise occurs in Pennsylvania, Maryland and Virginia; principally, however, in the condition of casts of the interior. From Cumberland, Md., I have received specimens from Mr. ANDREWS, as well as from the collections of Mr. R. P. WHITFIELD; and I am indebted to Dr. G. A. WILLIAMS for many fine casts and a few specimens retaining the shell, from Hardy county, Va.

Athyris vittata.

PLATE XLVI : FIGS. 1–4.

Athyris vittata : HALL, Thirteenth Report on the State Cabinet, p. 89. 1860.
Compare *Athyris concentrica*, *A. spiriferoides*, etc.

SHELL ovate-subquadrate, gibbous, with the mesial fold and sinus distinct; front conspicuously sinuate : hinge-line short : cardinal extremities rounded.

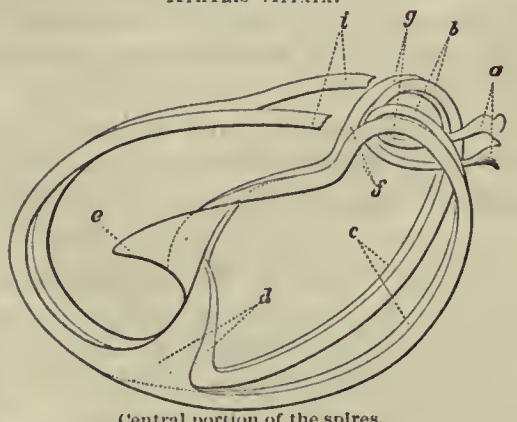
VENTRAL valve gibbous above, more convex than the dorsal; umbo prominent; the beak incurved and truncated in the plane of the longitudinal axis by a round foramen, curving very abruptly to the cardinal and cardino-lateral margins; the centre marked by a well-defined mesial sinus, which is continued nearly or quite to the beak, and becoming much deeper and subangularly margined towards the front.

DORSAL valve a little less gibbous than the ventral, sides regularly curving; the middle of the upper part distinctly prominent, and developed below in a strong mesial fold which is abruptly elevated in front.

SURFACE marked by regularly imbricating lamellose lines of growth, which, on the better preserved surfaces, are finely crenulate on their edges, and the intermediate spaces striate.

Interiorly the spires of this form, in their first volution and in the accessary lamellæ, are quite distinct from those of *A. spiriferoides*. The accompanying figure is an illustration of the first volution of the spires, with the accessary lamellæ.

ATHYRIS VITTATA.



Central portion of the spires.

The bases of the crura are shown at *a*, and these projecting a short distance forward make a somewhat abrupt retral curve, turning back in the direction indicated by the dotted lines *b*; and thence descending into the cavity of the dorsal valve, follow essentially the curvature of its outline, as indicated at *c*, to a point anterior to the middle of the length of the spiral curve. Here the branches of the loop are given off at *d*; and these projecting vertically into the cavity, are turned abruptly forward, and beyond the dotted line, form a solid pointed plate which projects far towards the anterior limits of the spires at *e*. The posterior portions are produced backwards, and gradually ascending, continue parallel and in close proximity as far as *f*, where they diverge, sending off a fillet on each side which at *g* assumes the curvature of the normal lamellæ of the spire, following the same course into the cavity of the valve, and extending forward to the origin of the process forming the loop, they are united to the proper spiral lamellæ at *h*, which then continue simple as shown in their extension to *i*.

I had originally united this form of ATHYRIS with *A. spiriferoides* of the Hamilton group, regarding it only as a variety due to physical and geographical influences; but when the internal structure presents such wide differences, I can scarcely reconcile it with specific identity, if the distinction of species is to be preserved upon any ground except that of arbitrary authority. In the examples before us, if we admit such external and internal variations as incident to the species, it seems to me very difficult to say where these variations may end, and characters of true specific importance begin. At the present time I am not prepared to regard this wide departure in the features of important internal organs as one of variety merely; and while the external differences alone might not have been a sufficient reason for specific distinction, I must regard them when thus combined, as entitled to this consideration. Unfortunately the condition of the specimens is such as to afford only rare opportunities of studying the interior.

The figures given (Pl. 46, figs. 1–4) illustrate the general form and character of the species as it occurs at the Falls of the Ohio. A farther comparison with specimens from Iowa, which I have described as *A. vittata*, reveals no external differences beyond the smaller size of the last named species. Under those circumstances I prefer to refer the present one to the species already described, than to add another name to the list of species. The specimens under examination present many external characters in common with some of the European varieties of *A. concentrica*.

Geological formations and localities. The original specimens upon which *A. vittata* was founded were from Iowa city, in rocks of the age of the Hamilton group, and it occurs likewise at New-Buffalo in the same geological horizon. The species of the form figured on Plate 46 occurs in the Corniferous limestone at the Falls of the Ohio, at Charleston-landing and other places.

Athyris cora.

PLATE XLVII.

Athyris cora : Hall, Thirteenth Report on the State Cabinet, p. 94. 1860.

Shell depressed suborbicular or transversely broad-elliptical, moderately gibbous; valves subequally convex.

Ventral valve somewhat more elevated than the dorsal, gibbous upon the umbo and much elevated above the opposite valve; apex incurved; outline regularly curving to the cardinal and lateral margins; mesial sinus more or less strongly defined, sometimes shallow and sometimes subangularly depressed and reaching nearly or quite to the beak.

Dorsal valve a little less elevated than the opposite, regularly convex and curving to the margins : the mesial fold is moderately elevated, sometimes rather abruptly defined at its margins, and flattened or a little concave above. Surface marked by fine concentric lines of growth and a few stronger parallel ridges or undulations.

The specimens are in the condition of partial casts, or with the shell partially exfoliated, so that the original exterior is not fully known. In these specimens, when the shell is exfoliated, there is a depressed line marking the centre of the mesial fold, and in some specimens this feature occurs without any appreciable elevation. So far as can be observed, the muscular impressions in the ventral valve are proportionally more expanded than in the *A. spiriferoides*, and those of the dorsal valve wider. The vascular impressions are sometimes very finely preserved beneath the inner laminæ of the shell, and the surface of the cast is strongly papillose.

In a very symmetrical specimen, the proportions of length and width of the dorsal valve are as eleven to fifteen, and the length of the ventral valve of the same individual is a little more than twelve. The greatest width of specimens is about $\frac{1}{16}$ of an inch.

This species differs from the *A. spiriferoides* in the character of the mesial fold and sinus, in the proportional greater convexity of the ventral valve, and greater elevation of the umbo; and there are probably other differences which would be discovered in the perfect exterior, or in the entire muscular impressions.

The figures 1–7 of Plate XLVII illustrate the general features of this species.

Geological formation and locality. In the Hamilton group at Delphi, New-York. A single specimen from the Chemung group is undistinguishable from those of the Hamilton group.

Athyris angelica.

PLATE XLVII.

Athyris angelica : HALL, Fourteenth Report on the State Cabinet, p. 99. 1861.

SHELL ovoid, gibbous, transverse or elongate ; proportions of length and width variable, the prevailing form longer than wide ; deeply sinuate, with the beak very prominent ; hinge-line short.

VENTRAL valve gibbous, most convex above the middle ; mesial sinus usually extending nearly to the beak, becoming abruptly and deeply depressed below the middle, and much expanded towards the front of the shell ; lateral portions of the valve gibbous, and abruptly curving towards the margins : beak much elevated and curved over the umbo of the dorsal valve.

DORSAL valve much shorter than the opposite, gibbous, transverse or as long as wide ; the mesial fold usually not conspicuous above the lower third of the valve : in the upper part the surface is a little more gibbous, and the striæ along this part are more straight or a little curved backwards, indicating the form during the successive stages of growth.

SURFACE marked by regular equidistant imbricating lamellæ or lamelliform striæ, the edges of which in perfect specimens are projecting and slightly crenulate. These lamellæ are marked by short interrupted radiating striæ, as shown in figure 20.

The interior of the ventral valve shows a semicircular perforation at the apex, opening on the lower side to a triangular fissure. The teeth are strong, and continued in plates to the base of the rostral cavity. The adductor imprints are strongly marked just below the rostral cavity, and the divaricator imprints occupy an ovate space below and on each side. Surface of cast, adjacent to the muscular imprints, strongly papillose.

The muscular imprints of the dorsal valve are not well preserved in any specimens in my collection. There is a slender longitudinal septum extending from the beak for one-half the length of the valve.

This species is distinguished from the others here described by the great inequality of the valves, and by the lamellose striæ which are not unlike those of *A. vittata* in the Hamilton group of the west. The specimens are for the most part poorly preserved, and occur as single valves which are usually partially exfoliated. Casts of the interior are not unfrequent, but the material is usually too coarse to preserve the finer markings.

The figures 9–13 of Plate XLVII illustrate the general characters presented by this species from several localities in Allegany and Cattaraugus counties. Figure 14 is the cast of a small ventral valve.

Figure 15 is the cast of an elongate form of the ventral valve. Figures 16–19 are illustrations of the cast of a gibbous form from the arenaceous beds in Cattaraugus county.

There may, perhaps, be some doubt whether this species will prove a true Athyris.

Geological formation and localities. This species is known to me only in the Chemung group. It occurs in the Genesee valley at Philipsburgh and Rockville, Allegany county; near Great-valley, Randolph and Cadiz in Cattaraugus county; and at Meadville in Pennsylvania.

Athyris ? polita.

PLATE XLVII.

Atrypa polita : HALL, Report on Fourth Geological Dist. N. Y. Tables of Organic Remains, No. 65, fig. 5. 1843.

SHELL subglobose or short ovoid, more gibbous in the upper part, with a distinct mesial fold and sinus.

VENTRAL valve scarcely more gibbous than the dorsal, the greatest gibbosity above the middle, flattened near the beak and at about one-third the length becoming depressed in an undefined sinus which expands and becomes deeper towards the front; beak closely incurved over the umbo of the opposite valve and perforated at the apex.

DORSAL valve with its greatest gibbosity a little above the middle, and flattened in the centre, curving abruptly to the beak and lateral margins; a broad mesial fold becoming defined at about one-third the length from the apex, flattened above, and very little elevated at the sides.

Surface, in well preserved specimens, marked by fine close concentric striæ, with indistinct radiating striæ; the concentric striæ sometimes crowded together in folds or ridges.

A gutta-percha impression from a mould of apparently the same species, and from which the natural cast, figures 27 and 28, was taken, is distinctly radiatingly striate, as shown in figure 30.

The cast of the ventral valve preserves evidence of moderately strong teeth with dental plates reaching to the bottom of the rostral cavity, where they are distinctly limited. The muscular area is only moderately impressed, and the adductor imprints are cordiform : the surrounding surface is papillose above and striate below.

In the dorsal valve the muscular imprints are elongate, situated about the centre of the valve, and separated by a median septum. The surface of the cast is more or less papillose-striate. In some of the casts the muscular imprints and septum are scarcely visible, but the latter, when entirely preserved, has extended below the middle of the length of the valve.

This is a shorter and more rotund species than either of those described, and maintains its proportions pretty uniformly. The smallest specimen measured has a length of four lines and a half, and the original specimen figured (figs. 23 – 26, pl. 47) has a length of eleven-sixteenths of an inch, with a width which is scarcely less, and the depth is seven-sixteenths of an inch. A single ventral valve measures a little more than three-fourths of an inch in length.

Figures 21 – 26 illustrate typical forms of this species. Figure 31 is a cast of the dorsal valve; and figures 27 – 29 are dorsal, ventral and cardinal views of a well marked specimen, which, however, has not its characters very strongly defined on the dorsal side.

The cast illustrating the interior characters, together with the gutta-percha impression from the mould of the same, have so much the general aspect and proportions of the *A. polita* that I have hesitated to separate them. All the original specimens of *A. polita* are more or less exfoliated, though apparently very nearly entire, but none of them give indications of continuous radiating striæ. Although the striated surface is a departure from the prevailing surface characters of Athyris, the cast does not present any features incompatible with a species of that genus.

Geological formation and localities. This species occurs in the Chemung group at Jasper, Steuben county; at Randolph and Albion, Cattaraugus county, and other places in this group in Southwestern New-York.

Genus Meristella* (Hall).

This genus was described in the Thirteenth Report on the State Cabinet in 1860, for shells which had heretofore been included under the genus Athyris and subsequently under Merista. Differing from Athyris, they possess the general external form and characters of Merista, but have not the internal septum so characteristic of the latter genus.†

* See note on page 297.

† In discussing the relations of this group of shells with Athyris and Merista above cited, I have made the following observations :

Among the fossils referred for many years to Terebratula, Atrypa, etc., European authors have separated the Genera Athyris and Merista; shells which have many characters in common, and which were indeed at first united under Spirigera or Athyris, until in 1851 the Genus Merista was proposed by Prof. Suess. In my later studies of the Brachiopoda of the American palæozoic strata, I have referred to the Genus Athyris certain species which have a subglobose or ovoid form, with lamellose surfaces, and without, or with scarcely perceptible radiating striæ; while other forms, which are less distinctly lamellose and always more or less distinctly radiatingly striate with fine concentric lines of growth, I have referred to the Genus Merista. Many of the latter have the general form and surface characters of *Merista* (*Atrypa*) *tumida*, Dalman, but are less ventricose : they all have internal spires, and when perfect, the beaks appear to be imperforate. The radiating striæ, though visible in well preserved specimens, are still more conspicuous in the partially exfoliated shell. *Atrypa tumida* of Dalman is cited by Davidson as one of the types of the Genus Merista.

I proposed last year (Twelfth Report on the State Cabinet) a separation of certain Merista-like forms, under the name Camarium, on account of the presence of an arching transverse septum in the ventral valve. Subsequently, a more careful consideration of the characters of Merista as given by Mr. Davidson, and an inspection of his figures, have shown me that this arching septum, in its attenuation towards the beak, is identical with the shoelifter process described as belonging to the Genus Merista. An examination of numerous specimens of different species of those which I have referred to the Genus Merista, shows no evidence of this process or septum; and the deep muscular impression below the rostral cavity, and the thickening of this part of the shell, are characters incompatible with the existence of the septum. Moreover I conceive that this arching septum, or the extension of the shoelifter process into the cavity of the valve, would produce such a modification of the soft parts of the animal that the inhabitants of these shells were generically distinct from those of the large uninterrupted cavity of the shells which I have heretofore referred to Merista.

In order, if possible, to reach a solution of the question, I have had the shell removed from a solid specimen of *M. tumida* (from Dudley, England), which is one of the types of the genus, and there is certainly no evidence of the septum or shoelifter process, but, on the contrary, the presence of all the characters marking the American species which I have referred to Merista in Vol. iii, Pal. New-York. At the same time, the *Merista* (*Terebratula*) *scalprum* of Barrande [*M. herculea* of Barrande, or *M. scalprum* of Rœmer], in the most solid of the specimens which I possess, readily reveals the presence of the septum.

The shells of this genus are oval, ovoid or suborbicular, elongate or rarely transverse; valves unequally convex, with or without a median fold or sinus; beak of the ventral valve often with a circular foramen, and incurved over the umbo of the dorsal valve. Area none; valves articulating by teeth and sockets; surface smooth, or with fine concentric lines of growth, and with very fine, indistinct or obsolete, radiating striæ.

Since this shoelifter process, or septum, was originally described by Prof. SUESS as characteristic of his Genus MERISTA, and the species designated by him as the types of this genus (the *M. scalprum*, *M. herculea* of BARRANDE) "do possess this feature, the genus must be retained for the species "with the shoelifter process."

It would appear, therefore, that the Genus CAMARIUM, proposed by me in the preceding Report, possesses characters identical with MERISTA as originally described by SUESS, but which have been overlooked to some extent in consequence of the reference to *M. tumida* as a typical form of the genus. * * * * At the same time, as the *M. tumida* of DALMAN, an English and Swedish species, in common with numerous well-marked forms in our Silurian and Devonian strata, do not possess this feature, we can no longer, with propriety, refer them to that genus.

With this restriction, the MERISTÆ proper consist of smooth, ovoid, circular or transverse shells, with usually a conspicuous sinus upon the ventral valve, and a corresponding wide, often undefined, mesial fold or elevation upon the dorsal valve; the hinge articulation being not very different from that of ATHYRIS, to which they are allied.

The interior of the ventral valve, however, is strongly distinctive; and the septum or shoelifter process is not unfrequently shown in the cleavage of the beak of that valve, in solid specimens, where the interior is inaccessible.

The forms which I have regarded as MERISTA are similar to those above; but instead of this septum, or shoelifter process, they have a deeply marked triangular muscular area just below the rostral cavity of the ventral valve, which is bordered on the anterior side by a callosity of the shell, and on the two other sides by the strong dental lamellæ. This feature is not conspicuous in ATHYRIS: the dental lamellæ in that genus are shorter and less strong, and the form of the muscular impression is different. The dorsal valve of those shells now under consideration has a longitudinal median septum; a feature which is obsolete, or partially obsolete, in the species of ATHYRIS. In the CAMARIUM, or MERISTA proper, the exterior of the ventral valve sometimes shows what appear to be two diverging septa, somewhat similar to those in the dorsal valve of PENTAMERUS, which are the margins of the shoelifter process.

The Meristidæ begin their existence, so far as we know, in the rocks of the Clinton group; and in this and the Niagara group there are several species, while they are more numerous in the Lower Helderberg group: they occur likewise in the Upper Helderberg rocks, and in the Hamilton group. MERISTA proper, so far as we know, appears first in the Lower Helderberg period, while ATHYRIS is known in two species for the first time in the Hamilton group [also in Upper Helderberg group].

Restricting, therefore, the signification of the Genus MERISTA to such forms as were originally included by Prof. SUESS under that name, it becomes necessary to designate those species of similar form, but without the peculiar appendage of the ventral valve, by another generic term; and I would therefore suggest the name MERISTELLA, proposed by me last year.‡

‡ Twelfth Report on the State Cabinet, p. 78.

The interior of the dorsal valve is marked by the presence of a strong hinge-plate or cardinal process; and from the base of this proceeds a thin longitudinal septum, which often extends for half the length of the valve.

The interior of the ventral valve shows a triangular fissure below the beak, which joins a semicircular perforation at the apex. At the base of this fissure are two strong teeth, which extend in thickened or slender plates to the bottom of the cavity, and curve around the upper part of the muscular area, which is broadly triangular or ovate.

There is sometimes a thickening of the shell at the base of the rostral cavity, which abruptly limits the muscular impression; but there is neither septum nor rudiment of one as in MERISTA.

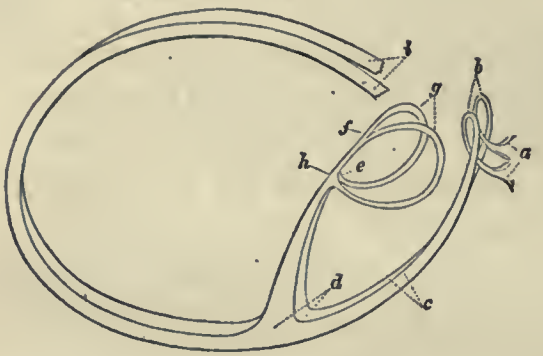
In well-preserved specimens of *M. haskinsi*, where the apex is not too closely incurved, the ventral beak has a circular foramen, and the triangular space below, which is usually filled by the beak of the dorsal valve, is closed by two deltidial pieces anchylosed in the centre. The latter feature has been observed in *M. barrisi*, and probably existed in all the species at some period of their growth.

The study of the interior has shown that the thickened bases of the crura extend forward for a short distance, or bend abruptly to the ventral side, but recurving, descend into the cavity of the dorsal valve, following its contour and that of the ventral valve in their succeeding volutions. In the bottom of the dorsal valve, the lamellæ, in the course of the first volution, are united by a loop which is produced by the extension of a slender process from the band on each side, and these are united at a greater or less distance from their origin. Beyond this junction the parts of the loop again divide, and each one is produced in a curving band which arches forward on the ventral side, and thence returning is reunited to the sides of the loop at or near the junction of the parts before noticed.*

* In the Canadian Journal of Industry Science and Art, for March, 1861, Mr. BILLINGS has undertaken to define the limits of the Genera ATHYRIS, SPIRIGERA, MERISTA, etc.; strenuously objecting to the introduction of the generic name MERISTELLA. At the close of the same article, he proposed

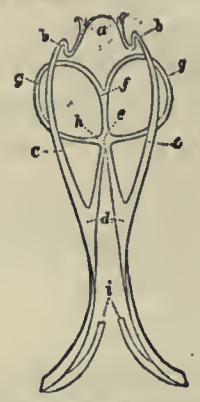
These features are illustrated in the accompanying diagrams; fig. 1 being an oblique lateral view of the central portion of the spires, and fig. 2 a view of the same parts from the dorsal side.*

MERISTELLA ARCUATA.



Showing the first volution of the spires, with loop, etc.

MERISTELLA ARCUATA.



Dorsal view of the central parts of the spiral lamellæ.

In these figures, *a* indicates the origin of the crura; *b* the recurvation of the lamellæ, which may be as represented, or with a simple retral bending without recurving upon itself in some species; *c* is the continuation of the lamellæ, which at *d* give off the processes forming the loop, and these become united at *e* and continue simple to *f*, where they bifurcate and continue in the direction *g*, returning again to the centre, and reuniting with the loop at *h*, or near the junction of the two parts before mentioned.

These characters of the spires and loop have been observed in the *M. lævis*, *M. arcuata* and *M. princeps* of the Lower Helderberg group, and in the *M. barrisi* of the Hamilton group; while the *M. nasuta* presents a slight modification in the extension of the parts of the loop, which ally it more nearly with ATHYRIS.

When compared with the spires of ATHYRIS as shown in the figures already given under that genus, as well as the illustrations of DAVIDSON and other authors, the differences are obvious. The parts of the loop in this genus, instead of curving forward and there uniting and turning backward and bifurcating, to form the accessary lamellæ, are continued from their origin obliquely backwards into the cavity of the ventral valve, and, then recurving upon themselves, are reunited laterally; while in ATHYRIS, they are intercalated between the first and second turns of the spire, and coalesce with the lamellæ of the latter.

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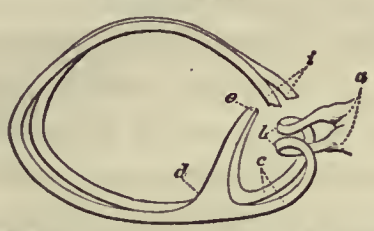
the generic name of CHARIONELLA; professing to "have ascertained the generic characters of the so-called *Atrypa* or *Athyris scitula*," a species possessing the characters of MERISTELLA, and none, so far as known, which do not belong to that genus. He has subsequently united under the same name several other species of the latter genus. It is scarcely necessary to add that the characters of hinge, as described and illustrated in the dorsal valve of CHARIONELLA by Mr. BILLINGS, do not exist in any species of this family (Spiriferidæ) of Brachiopoda.

* The words upwards and downwards, used in the descriptions of the spires in ATHYRIS and MERISTELLA, have reference to the position of the figures only, which are represented with the dorsal side below; since the illustrations could be more satisfactorily given in this position.

At the same time, an examination of the Niagara species referred by me to the Genus MERISTELLA presents a different condition of the interior, and shows the lamellæ of the spires united by a simple loop only.

This feature is illustrated in the accompanying diagram, which represents a single turn of the spiral lamellæ, from their origin at *a*, to *i* where the bands are cut off. The thickened bases of the crura are represented at *a; b* is the point of recurvation, *c* the continuance of the lamellæ in the dorsal cavity, and *d* the expansion on the inner side into long processes which unite at *e*, forming the loop.*

MERISTINA MARIA;



Showing the first volution of the spiral lamellæ.

The same characters have also been observed with equal distinctness in *M. nitida* of the Niagara group. In neither of these species is there any indication of accessary lamellæ as in ATHYRIS, nor evidence of the extension of the loop beyond the point *e;* and we are therefore induced to believe that the simple character of the spires in these forms will constitute another distinction, which may conveniently be termed MERISTINA.

Meristella nasuta.

PLATE XLVIII.

Atrypa nasuta : CONRAD, Ann. Report on the Palæontology of New-York, p. 18.
Meristella nasuta (CONRAD sp.) : HALL, Thirteenth Report on the State Cabinet, p. 93. 1860.
Meristella elissa : HALL, Fourteenth Report on the State Cabinet, p. 100. 1861. Fig. 21 & 22, Fifteenth Report. 1862.
Meristella nasuta : HALL, Fifteenth Report on the State Cabinet, p. 160; figs. 17–19, p. 161. 1862.
Athyris clara : BILLINGS, Canadian Journal, p. 274. 1860.
Athyris clara : Geology of Canada, p. 373, fig. 397. 1863.

SHELL suboval, ovate or subrhomboidal, the greatest width near or a little below the middle; the length equalling or greater than the width. Valves convex, the ventral valve gibbous. A nasute or linguiform extension of the front in old shells.

* The point of junction in these parts varies in different species; and even in what appear to be the same species, the points of junction are not identical in all individuals.

Ventral valve much the more convex, the greatest convexity being a little above the middle, becoming gibbous and extremely arcuate in old individuals, curving abruptly to the sides and cardinal margins, and more gradually to the front : umbo extremely prominent; beak neatly rounded and closely incurved, standing at a right angle with the plane of the axis, or in old shells directed forwards. The anterior portion is produced into a nasute or linguiform extension, usually without a sinus or any depression of the surface. In the young or half grown individuals, this feature does not appear.

Dorsal valve less convex than the opposite, moderately and regularly convex in the young shell, becoming in the old shells gibbous above, curving regularly to the sides, and often a little flattened at the baso-lateral margins; at about the middle of the length, or sometimes above, the central portion of the valve becomes more gibbous, and towards the front is abruptly elevated into a short rounded prominent fold, corresponding to the linguiform extension of the opposite valve. The beak is moderately incurved, lying close beneath that of the opposite valve.

The general aspect of the surface is that of a smooth shell with a few concentric lamellose lines. In perfect specimens, however, the entire surface is marked by fine close concentric striæ, and usually by indistinct radiating striæ, which are often more conspicuous in the partially exfoliated shell, and still more distinct in some of the casts.

The interior of the ventral valve preserves the generic characters in a marked degree, in the open fissure beneath the beak, which is terminated by a subcircular perforation; in the strong dental plates, and deeply marked muscular impression, as shown in fig. 18 of Plate xlviii. The inner surface surrounding the muscular impression is radiatingly striated. The reverse of these features is shown in the casts of smaller individuals, from the Schoharie grit, figs. 3 and 4, where the muscular impression and rostral cavity are excessively developed; also in the larger and more symmetrical figures 5 and 6.

The interior of the dorsal valve shows a strong cardinal process, with a shallow spoon-shaped depression in the centre, margined by deep teeth sockets. The muscular area is elongate-ovate, broader above, and divided through the centre by a thin elevated septum. These features are shown in fig. 17; and also in the casts of the dorsal side, figs. 1, 2, 20 and 22.

The crura apparently bend downwards from near their origin; thence recurving, they follow very closely the contour of the dorsal valve, making thirteen or more turns in an individual of medium size. Spires, slender and simple. The spires and median septum are shown in figure 19.

In the young shell, this species is symmetrical and nearly circular; the smallest measured specimen has a length and width of about half an inch. The valves are very regularly convex, the dorsal valve becoming gibbous in the upper part, with a scarcely perceptible undulation of the front margin. Some specimens of an inch in length have an equal width; but generally as the shell becomes older, the length exceeds the width. The nasute extension in front is at first acute in most specimens, becoming broader and linguiform in older specimens.

The figures on Plate XLVIII, from 7 to 16 inclusive, show the prevailing form and features of the genus.

The specimen illustrated in figures 23–25 is that which I have described as *M. elissa;* but this is only an extreme form of *M. nasuta* with an unusual linguiform extension, a remarkably gibbous and arcuate ventral valve, and a dorsal valve less convex, as in some smaller individuals.

This species first appears in the Schoharie grit, where it is sometimes very fully developed, but frequently is only obtained in meagre casts, like figures 3 and 4. It is more abundant in the Corniferous limestone, here presenting its greatest extremes in form and proportions.

This shell is described by Mr. BILLINGS, *loc. cit.*, under the name of *Athyris clara;* but the same has been long known as *Atrypa nasuta* of CONRAD, and I preserve that specific name as having priority.

Both in general exterior form and internal characters this species bears much resemblance to *Meristella* (*Atrypa*) *tumida*, DALMAN; but in that one there is a more distinct sinus in the ventral valve, while the umbo is more gibbous, the beak larger and more incurved, and the entire shell is comparatively more ventricose. The muscular area in the ventral valve is of the same shape, but narrower than the prevailing form in our species.

Geological formations and localities. This species occurs in the Schoharie grit, in Albany and Schoharie counties, usually of medium size and well marked characters, and sometimes attaining larger dimensions. It occurs in the limestone of the Upper Helderberg, in Albany and Schoharie counties, and at nearly all the localities of that rock as far as the Niagara river; particularly at Clarence and Williamsville in Erie county. It is found at several localities in Canada West; also at the Falls of the Ohio and at Columbus and Millford, Ohio, and probably at Sandusky and other localities of the Corniferous limestone in the West. Some large imperfect valves in the Hamilton shales of Central New-York may probably be of this species.

Meristella scitula.

PLATE XLVII.

Atrypa scitula : Hall, Geol. Report of the Fourth District New-York, p. 171, f. 1. 1843.

Not *Athyris (?) scitula* : Hall; Billings in Canadian Journal (n. s.), No. xxvii, p. 278, f. 35 & 36. 1860.

Charionella circe : Billings, Canadian Jour. (iv s.); No. xxxviii, p. 273, f. 100. 1861.

Not *Terebratula circe*, Barrande (*Spirigera circe*, d'Orbigny), Naturwissenschaftliche Abhandl., pa. 393, pl. 10, f. 6 (1857), which is apparently congeneric, and a true Meristella.

Shell ovate or ovate-spatulate, compressed towards the base.

Ventral valve the more convex, sometimes gibbous above the middle, depressed in the lower part; umbo prominent, with the beak elevated and incurved above the umbo of the opposite valve. The shell curves gently to the base and baso-lateral margins, but becomes abruptly incurved above the middle, and concave on each side for some distance below the beak; the proportions of breadth above are as six to five, or seven to six.

Dorsal valve depressed convex in the lower part, more convex and somewhat gibbous above the middle; beak small and rather prominent.

Surface marked by fine concentric striæ, which, from the usual partial exfoliation of the shell, are often scarcely perceptible : more rarely some remains of obsolete interrupted radiating striæ are perceptible. The shell, as it usually occurs, is smooth and glabrous.

This species has the usual features of others of the genus. It differs from *M. doris* in being less gibbous, with a lesser arcuation of the ventral valve, the upper part less elongate and attenuate, and a less extensive flattening of the sides of the shell.

It differs from *M. barrisi*, in being less gibbous and proportionally broader. It is more elongate than *M. haskinsi*, less rounded in the outline of the lower part, and does not present the conspicuous rounded foramen of that species. It has not proved a common species in the limestone, only a few specimens being known.

Geological formation and localities. This species occurs in the Corniferous limestone at Williamsville and Clarence-hollow, Erie county, N. Y.

Meristella doris.

PLATE L.

Meristella doris : Hall, Thirteenth Report on the State Cabinet, p. 84. 1860.
Charionella doris : Billings, Geology of Canada, p. 374. 1863.

Shell subovate, elongate, gibbous above and more or less compressed below the middle, with the anterior and antero-lateral margins attenuate and sharp; sinuate on the ventral side below the middle, and the front produced in a broad extension.

Ventral valve a little more or less convex than the dorsal, gibbous above the middle : a mesial depression, often beginning about the middle of the length, becomes broader and deeper towards the front, sometimes affecting nearly the entire width of the shell. This sinus is sometimes barely perceptible, and is sometimes a narrow, almost linear depression in the upper part of the shell. The umbo is prominent and the beak strongly incurved : an angular ridge extends from this point obliquely on each side to below the extremities of the hinge-line, on which the shell is bent abruptly (and on the upper part acutely) inwards. The central upper portion of the valve is prominent, and between this and the oblique ridge the surface is depressed or flattened. The apex is usually apparently closed, but from accident or otherwise it often presents a circular foramen : the triangular space beneath is closed by deltidial pieces, or sometimes open.

Dorsal valve sometimes more convex than the opposite, usually gibbous in the middle and above, and curving rather abruptly towards the lateral margins, in the older shells it becomes a little flattened or even concave near the edge. The central elevation continues to the fron without becoming a distinct mesial fold.

Surface marked by fine close concentric striæ, beneath which are distinct radiating striæ, and the latter become more distinct on the partially exfoliated surfaces.

The cast of the ventral valve shows a large rostral cavity, with evidences of strong teeth and extended dental plates. The muscular area is narrow and elongate. In the dorsal valve, the muscular imprint reaches half way from beak to base of the valve; the septum scarcely reaches so far.

This shell is usually readily distinguished from the other species of the Upper Helderberg and Hamilton groups by its elongate form, which is compressed and laterally expanded towards the front; by the remarkable arcuation of the ventral valve, and the strong angular lateral ridge which extends from a little above the middle to the apex, nearly in the same curve as the junction of the valves in their anterior half.

In this feature, and in the less incurvation of the beak, it is distinguished from some varieties of *M. nasuta;* and in the same manner it is distinguished from *M. barrisi* and *M. haskinsi*, which are always proportionally shorter shells.

The figures 2–7 illustrate the characteristic forms of this species; figures 8–10 show the extreme features of the larger individuals. The extreme length is about one inch and three-fourths, with a width of a little more than an inch and one-fourth. Figure 11 is the dorsal valve of a large individual which is much broader than usual in proportion to its length. Figure 12 is a cardinal view of a cast of this species, showing the median septum of the dorsal valve, and cavities made by the dental lamellæ of the ventral valve.

A single specimen, figure 1, from the Schoharie grit, appears to be of this species.

Geological formation and localities. This species has been chiefly obtained from some loose masses of the upper part of the Corniferous limestone near Williamsville, Erie county. One specimen only has been obtained from the Schoharie grit, in Schoharie county.

Meristella barrisi.

PLATE XLIX.

Meristella barrisi : Hall, Thirteenth Report on the State Cabinet, p. 81. 1860.

Shell ovoid, more or less elongate and sometimes broadly ovate, gibbous: valves subequally convex, sinuate in front.

Ventral valve gibbous in the middle, the greatest convexity a little above the middle of its length, and abruptly sloping to the sides, flat-

tened below the middle, becoming depressed towards the front, which in old shells is produced into a short linguiform extension : umbo gibbous, the beak arching over the umbo of the opposite valve and not closely appressed.

Dorsal valve little longer than wide, varying from moderately convex to gibbous, the greatest convexity being about the middle of its length ; without distinct mesial fold, but abruptly elevated near the anterior margin, corresponding to the depression on the opposite side.

Surface smooth, or marked by regular concentric striæ which are sometimes crowded into wrinkles near the margins of the valves. The exfoliated shells sometimes show indistinct radiating striæ.

The muscular impression in the ventral valve is triangular, and usually not deeply marked. The dorsal valve has a distinct median septum which extends nearly half the length of the valve : muscular area narrow, elongate.

This species presents considerable variety of form, from almost symmetrically oval to broadly ovate with the greatest width below. The older shells are for the most part gibbous, but some specimens are compressed in the lower half of the length. The mesial sinus is not usually a very distinctive feature in half-grown shells ; but in some individuals it begins about the upper third of the shell, and affects the lower half and anterior part of the valve.

The largest individuals have a length of about one inch and a quarter, with a width of one inch ; in other specimens, a length of one inch and an eighth gives a width of one inch and a depth of three-fourths of an inch. In a gibbous and somewhat elongate form, the depth and width are as 5 to 6, and the length $8\frac{1}{2}$.

Figures 5–12, and 16 & 17, represent the most characteristic forms.

Figures 13 & 14 are of an extreme form.

Figure 20 is one of the broader forms.

Figures 21 & 22, dorsal and front views of a cast of this species.

Geological formations and localities. This species has been found chiefly in a limestone of the Marcellus shade, near Le Roy, N. Y. It occurs in the Hamilton group, near York in Livingston county, New-York.

Meristella haskinsi.

PLATE XLIX.

Meristella haskinsi : Hall, Thirteenth Report on the State Cabinet, p. 84. 1860.

Shell broadly ovate, more or less gibbous; length and breadth nearly equal, the greatest width anterior to the middle; slightly sinuate in front. In many well-formed specimens the length and width are about equal; when the length is greater, it is due to the extension of the beak of the ventral valve.

Ventral valve regularly convex, often gibbous above the middle, and curving regularly to the sides and more gently to the front, which is sometimes a little impressed at the margin by a broad shallow sinus : beak elevated, slightly incurved and broadly truncated by a circular foramen. The triangular space beneath the apex is occupied by deltidial plates, which appear to be closely anchylosed in the centre.

Dorsal valve usually a little wider than long, moderately convex in young shells, gibbous in the middle and above in older specimens, curving regularly to the sides and front, and scarcely affected by the slight elevation near the anterior margin : beak short, and neatly incurved beneath the deltidial plates of the opposite valve.

Surface marked by fine concentric striæ, which are raised and thread-like, and sometimes crowded together in fascicles : these appear also to be indistinctly radiate or crenulate. In exfoliated specimens there are sometimes distinct radiating striæ upon the surface.

The rostral cavity of the ventral valve is narrow, the teeth are of moderate strength, and the dental plates reach the bottom of the cavity and extend forward; the muscular area is broadly triangular and strongly striate. In the dorsal valve the muscular area is ovate or cordiform, and extends below the middle of the valve; the low slender septum extends a little beyond the muscular area.

This species is quite distinct, in its various phases, from the *M. barrisi*, which is more gibbous, with the ventral beak more closely incurved. In well-preserved

specimens, the beak of *M. haskinsi* is sufficiently elevated to allow the deltidial covering of the fissure to be visible. In specimens where the surface is well preserved, the striæ offer a distinguishing character.

The figures 23–35, Plate XLIX, illustrate this species in its principal varities of form and size. In figures 32 & 34, the deltidial plates beneath the foramen are visible.

Figure 35 is a partial cast of the dorsal valve, showing the filling of the rostral cavity and the form of the muscular impression.

Figure 36 is a partial cast of the dorsal valve, preserving in part the muscular impression.

The fossil figured in the Report of the Fourth District, p. 202, fig. 5, is probably an exfoliated specimen of this species.

Geological formation and localities. This species occurs in the shales of the Hamilton group, on the shores of Seneca lake, at Geneseo, York, Moscow and Leroy, in Livingston county, and at Eighteen-mile creek in Erie county.

Meristella rostrata.

PLATE L.

Atrypa rostrata : HALL, Report on Fourth Geol. District of New-York, p. 202. f. 2. 1843.

SHELL small or of medium size, ovate, rounded below and often subattenuate above; valves subequally convex; length and breadth about as eleven to eight or nine.

VENTRAL valve scarcely more convex than the dorsal, a little gibbous above the middle, gradually curving to the basal and baso-lateral margins, while above the middle the edges are abruptly incurved : umbo prominent; beak more or less strongly incurved over the umbo of the opposite valve; the lower part of the valve, and sometimes the entire length, marked by a shallow rounded sinus.

DORSAL valve regularly convex, somewhat more prominent above the middle; slightly or not at all elevated in front from the influence of the sinus of the ventral valve.

SURFACE of partially exfoliated valves marked by conspicuous but slender and distant radiating striæ : fine and closely arranged concentric striæ mark the entire surface, and towards the margins these are crowded in strong folds.

Shells of this species are scarcely three-fourths of an inch in length in the largest specimens observed. The proportions of length and breadth vary considerably.

Figures 13 - 17 are illustrations of this species.

Geological formations and localities. This species occurs in calcareous beds in the upper part of the Hamilton group, at Eighteen-mile creek; and in the Tully limestone, near Ovid, in Seneca county.

Meristella meta (n. s.).

PLATE XLIX.

Shell subglobose, or very gibbous, short ovate; the valves subequally convex, marked by a conspicuous sinus in front; hinge-line about two thirds the width of the shell.

Ventral valve very gibbous; umbo prominent, with beak abruptly nasute; the upper part of the valve marked by a shallow scarcely defined depression, which becomes a deeply marked subangular sinus in front.

Dorsal valve regularly convex, gibbous in the middle and above; anterior margin broadly sinuate, and the lower part of the valve marked by a narrow median depression.

Surface concentrically striated, with faint indications of interrupted radiating striæ. In the specimens examined the shell is partially exfoliated, and the entire surface-characters cannot be ascertained.

The figures 1 – 4 of Plate xlix illustrate this species.

This fossil is referred to Meristella from its general form, the fibrous texture of the shell, and the form of muscular area in the ventral valve.

Geological formation and localitiy. In calcareous bands in the Hamilton group at Delphi, Onondaga county, N. Y.

Meristella? —— ?

PLATE XLVII.

The illustrations, figures 32 and 33 of this plate, are of casts of what appear to be a species of Meristella from the Chemung group, though no exterior of a similar shell has been found in the rocks of that formation.

Meristella unisulcata.

SUBGENUS ? PENTAGONIA (Cozzens).

PLATE L.

Atrypa unisulcata: Conrad, Annual Report on the Palæontology of New-York, p. 56. 1841.
Rhynchonella unisulcata: (Conrad, sp.) Hall in Tenth Report on the State Cabinet, p. 125. 1857.
Atrypa unisulcata: referred with doubt to Meristella, and name Goniocœlia proposed, in Fourteenth Report on the State Cabinet, p. 101. 1861.
Compare *Pentagonia peersii*, Cozzens, Annals of the New-York Lyceum, Vol. iii, pa. 158, pl. x, f. 2 *a*, *b*. 1846.

Shell subtrigonal, quadrilateral or sometimes subhexagonal in outline, wider in front, with the sides sometimes sloping from the beak; and in others, the hinge-line extended nearly straight, and the sides nearly rectangular to it. A wide mesial depression on one side, with prominent elevation on the other.

Ventral valve with a broad deep mesial sinus which occupies nearly the whole width of the valve, and is bounded on either side by an angular elevation which extends from the beak to the baso-lateral angles. The portion of the valve outside of the limitation by the sinus is abruptly inflected upwards, often nearly at right angles; the umbo is prominent, and the beak is incurved over the umbo of the dorsal valve.

Dorsal valve gibbous in the middle; the centre occupied by a prominent mesial fold, from which the surface slopes abruptly to the lateral angles, becoming more or less concave within the lateral and cardino-lateral margins. The mesial fold is marked along the centre by a single deep groove, which extends to the beak of the valve.

Surface marked by fine concentric striæ, and sometimes by strong imbricating folds. In well preserved surfaces the striæ and undulations are bent backwards in the middle of the mesial sinus, indicating a mode of growth in the shell corresponding to the sinus in the mesial fold of the opposite valve. There are also slight indications of interrupted radiating striæ. In the specimen from the Hamilton group

there are appearances of faint undefined continuous striæ. The specimens from the limestone are for the most part partially exfoliated, or have the shells silicified, by which the finer markings are obliterated.

The interior of the ventral valve shows a perforation in the beak, opening below into an angular space which has been occupied by the beak of the dorsal valve, and thence communicating with the main cavity of the valve. The base of the fissure is margined on each side by a strong tooth which extends in strong dental plates to the bottom of the cavity, and these are often continued in a thickened ridge bordering the muscular impression. The imprints of the adductor muscles are opposite the bases of the dental plates, and below and on either side are the imprints of the broad divaricator muscle.

In the dorsal valve the cardinal process is broad and strong, the crural bases somewhat widely diverging, and the centre abruptly depressed; the teeth-sockets are large, and supported by strong lamellar callosities which extend along the inner side of the valve nearly parallel to the exterior margin. The muscular imprints are divided by a low distinct septum.

This shell presents considerable variation in its forms and general aspect, though always preserving its unmistakable character. In young and half grown shells, where the hinge-line is but little extended, it has a general triangular form, as in figures 21 and 22; when the hinge-line becomes extended and the sides nearly straight with a moderately curving base, it is quadrangular, as in figures 18 and 19. Figure 26, upon the ventral side, is somewhat hexagonal; while figure 33 is decidedly pentahedral in outline. There is rarely some little elevation in the centre of the mesial sinus, and sometimes a groove with an elevation on either side.

The beak of the ventral valve is sometimes not closely pressed upon the dorsal umbo, but is usually so, and sometimes to such a degree that the apex is depressed into the groove of the mesial fold.

I have heretofore (Fifteenth Report on the State Cabinet, p. 147) called attention to some peculiarities near the cardinal margin of this species. In a cardinal view of a well preserved specimen from the Upper Helderberg limestone of New-York (fig. 28), there is a ridge on the cardinal margin crossing the hinge-line with slight obliquity, and occupying a space on both sides. In a specimen from the Hamilton group, this fold is more oblique, rising from near the beak, as shown in figure 35, Plate L; while there is a second fold on the side of the shell.

In a specimen from the Upper Helderberg limestones of the Falls of the Ohio (fig. 32 of pl. L), the fold is sharp and clearly defined, slightly oblique and limited to the dorsal valve, being intermediate in character to the former two; while the specimen is more gibbous than usual.

I have heretofore proposed (loc. cit.) to designate these varieties of *Meristella unisulcata*, thus recognized, as var. *uniplicata* for the specimens from the western limestones, and as var. *biplicata* for the Hamilton group form.

Geological formation and localities. This species is not uncommon in the Upper Helderberg limestone, in Albany and Schoharie counties, and generally throughout the extent of that formation within the State; though nowhere abundant. It occurs in the same limestone at the Falls of the Ohio, and in Canada West. In the Hamilton group, it has been collected on the shore of Canandaigua lake. Casts of the same species have also been observed in the Oriskany sandstone.

NOTE. I would, in this connection, call the attention of the student to the illustrations of the internal spires of ATHYRIS, MERISTELLA and MERISTINA. The modification of the parts are confined to the connecting loop of the crura; and neither in these, nor in any of the genera of the SPIRIFERIDÆ, is there any important variation in the form of the spires proper, while there are various modifications of the loop; and I am disposed to believe that others will yet be found, perhaps even in the Genus SPIRIFERA itself. These modifications of the form and direction of the parts become exceedingly interesting when compared with the various forms of the loop shown in the several genera of the Family TEREBRATULIDÆ, the most of which began their existence upon the waning of the spire-bearing forms, or acquired their fullest development in later geological epochs where the SPIRIFERIDÆ are comparatively rare or entirely unknown. This modification of crura and loop in the later genera is developed more extremely in the absence of spires, which acquired their greatest development in medial geological times, or about the Devonian or Carboniferous periods, almost at the same time that the terebratuloid genera began their existence.

Genus Atrypa (Dalman).

SPIRIGERINA (d'Orbigny).

The Genus Atrypa was founded by Dalman in 1827, to include a group of palæozoic shells which he described as "*inequivalve, biconvex, hinge-line "rounded, beak of larger valve covering the base of smaller valve, apex "imperforate.*"

Under this genus the two first named species are *A. reticularis* of Linnæus and *A. aspera* of Schlotheim, both of which have a perforation in the apex of the ventral valve, though it is often concealed by the curvature of the beak. Notwithstanding that the name in its signification is a misnomer, it has been very generally adopted, and for a long time it was used by some authors to include species usually referred to Terebratula, but which have only a remote relation to that genus, and are now distributed under various generic designations.

Restricting the signification of the term Atrypa to forms congeneric with those above referred to, we have a well-defined and strongly marked group of shells which may be characterized as follows:

Shells suborbicular, transverse or elongated; valves articulating by teeth and sockets: beak of the ventral valve produced and incurved; the apex truncated by a small round perforation, which is sometimes separated from the hinge-line by a deltidium; a false area in some forms well-defined, but often not existing in the same species.* This valve is more or less convex or nearly flat, sometimes with a broad and well-defined sinus, and often with a scarcely perceptible depression. Dorsal valve convex, often extremely gibbous; with or without a mesial fold.

* This false area is formed by the thickening of the shell in the bottom and sides in the upper part, and the final filling up of the rostral cavity above the line of the teeth; the pedicel-groove being sometimes visible to the base of the area, but there is scarcely evidence of its passage beneath it, and the apex is apparently solid. The condition of the shells examined, however, is such that there possibly may have been a minute foramen in the living shell, which has been closed by mineralization in the fossil.

Surface smooth, striate or costate, and often strongly imbricated by squamose lines of growth, which are sometimes produced in foliacious expansions, nodes, or tubular spines. Structure fibrous.

In the ventral valve there is a strong tooth on each side at the base of the broad fissure: these teeth are somewhat bilobed at their summit, with a broad crenulated groove on the back: from the base of the teeth a curving ridge extends forwards, and partially encloses a broad muscular area.

In the dorsal valve, the hinge-plate is usually or always divided in the middle, with a distinct toothlike plate on each side, and the crura originating on the outside of these, close to the dental sockets; while on the outside of the latter, close to the shell margins, there is on each side a crenulated fold, which occupied the groove at the base of the tooth, and this appears to be of generic significance. The spires originating from the crura form two large hollow cones which are directed into the cavity of the dorsal valve, their adjacent sides being flattened, and the apices brought close together near the centre of the bottom of the cavity. The extreme gibbosity of this valve in many of the older shells gives great space for the development of the spires.

The crura are usually represented as having a pointed process from near the base of the spires on each side, directed towards the centre. These processes, however, unite in the cavity of the dorsal valve to form a loop connecting the spires.*

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*While this volume has been passing through the press, it has been shown by Mr. R. P. Whitfield that the short processes usually represented near the base of the crura in the spires of Atrypa are directed into the cavity of the dorsal valve, and are there united to form a loop, and that the character of this loop varies in different species, or in forms recognized as simple varieties of *Atrypa reticularis* (See Nineteenth Report on State Cabinet). I have also received, some time since, from Dr. C. Rominger, of Ann Arbor, Michigan, a specimen of the *Atrypa nodostriata*, showing the spires, and which by farther cutting has revealed the connecting loop. A specimen of *A. reticularis*, sent me by Dr. Knapp, of Louisville, Ky., from the Falls of the Ohio, preserves the spires and connecting loop, all heavily covered by chalcedonic quartz; and another specimen from the same locality has, by a careful removal of the ventral valve, revealed the spires and loop. The same features are also shown, although in a less perfect manner, in a silicified specimen from the Hamilton group of Iowa, received from Mr. O. St. John.

The muscular area in the bottom of the dorsal valve is usually divided by a median ridge; and in old shells of some of the species, this area becomes very strongly defined.

The vascular impressions, in both valves, originate on each side near the base of the muscular area, and divide into two principal trunks which diverge towards the hinge-line and the front of the shell, and give off numerous lateral bifurcating branches.

The prevailing and conspicuous forms of this genus have been generally referred to two species, or rather to a single species, the *Atrypa reticularis* of LINNÆUS and its varieties; though more recently the *A. desquamata* of SOWERBY has been doubtfully admitted as a distinct species. My own investigations do not lead to the adoption of this view, though I admit that there are many difficulties in the way of specific determination, especially where the shells are exfoliated or compressed; but the examination of large numbers of individuals, together with the interiors of many of them, has compelled me to recognize as distinct species some of those which are usually considered as varieties only. How far the complete study of the interior structure, and of the spires, will sustain the separation of species, remains yet to be determined.

In order for a satisfactory solution of all these difficulties, a series of observations should be made upon extensive collections of individuals from widely separated localities in the same geological horizon, and also from different geological formations, to learn the effect of geographical and chronological influences. I conceive that until such investigations shall have been made, we are not prepared for a final determination of the questions of specific difference or identity.

Two species of this genus are of common occurrence in the Niagara and one in the Lower Helderberg group; and though I have referred the more common form to *A. reticularis*, there is usually no difficulty in recognizing the specimens from each formation, or in distinguishing them from those of the Upper Helderberg and Hamilton groups. The same observations are almost equally true of those in the higher rocks; but at the same time we find strongly marked features of distinction in individuals from widely separated localities of the same formation.

Atrypa impressa.

PLATE LI.

Atrypa impressa: HALL, Tenth Report on the State Cabinet, p. 122 (Pal. Fossils, p. 82). 1857.

SHELL somewhat ovoid, often extremely gibbous; length and breadth nearly equal.

VENTRAL valve depressed convex in the lower part, becoming gibbous above, more prominent along the middle, but without any defined elevation, and without sinus, except in very rare examples where the extreme front of the shell is bent upwards in the middle: beak closely incurved over the umbo of the opposite valve.

DORSAL valve the larger, very convex, and becoming extremely gibbous in full grown and old shells. A more or less distinct mesial elevation marks the lower half of its length: this is often flattened, giving an obtusely angular outline, and the centre is marked by a narrow depression: the front is squarely truncate or impressed.

SURFACE marked by numerous radiating striæ or costæ, which are frequently bifurcated, and crossed by numerous concentric lamellose lines of growth.

The casts of the interior, which are more abundant than any other condition of the fossil in the Schoharie grit, present considerable variety of aspect. The cast of the ventral valve is usually a little convex, or nearly flat outside of the muscular area, and often a little more prominent in the middle than at the sides. The muscular area is broad flabelliform, wider than long, depressed and smooth on each side above, with a central prominence for the attachment of the adductor muscles, from which there is usually a sharp carina extending to the beak: there is also a less conspicuous ridge on each side, extending obliquely from the apex to the base of the cavity left by the teeth. Outside of the muscular area the surface is strongly papillose, and sometimes marked by vascular impressions.

The casts of the dorsal valve present all the varieties from moderately convex to extremely gibbous. In the younger and less convex forms, there is usually a median depression more or less conspicuous; the muscular area is not sharply defined, but is distinctly bilobed, the upper parts deeply striated, and a slender ridge in the bottom of the depression. In older shells the muscular area becomes strongly defined and extremely prominent, rising conspicuously above the general gibbosity of the upper parts of the cast. The cast of the rostral cavity is neatly defined and limited on either side by the imprints of the crural bases, while outside of this are the characteristic crenulated impressions which mark this part of the hinge-line in well preserved specimens of this and other forms of the genus.

This species has usually been regarded as a variety of the *Atrypa reticularis*, which is recognized as so widely distributed in several geological formations. It may be difficult to decide what form shall be assumed as the typical *Atrypa reticularis*, among those which occur in all the formations from the Clinton group to the Chemung group inclusive. When compared with the so-called *A. reticularis* of the Niagara group, the form is more robust, the ventral valve without sinus, and the dorsal valve flattened or depressed in the middle of the lower half of its length, while the striæ are finer and less conspicuous. The same is true when compared with the *A. reticularis* from the Lower Helderberg group, and also with those of the Corniferous limestone and Hamilton group.

Geological formation and localities. This form of ATRYPA occurs in the Schoharie grit, at Schoharie, Knox, Clarksville, Coeymans and other places in New York. It is not known to me in any other geological formation.

Atrypa reticularis.

PLATES 51–53 A.

Anomia reticularis: LINNÆUS, Syst. Nat. ed. xii, p. 1132. 1767.

Terebratula pectinatæ, T. subtillissime striatæ, T. cancellatæ, T. minutissime striatæ: SCHRÖTER, Abhandlungen über verschiedene Gegenstände der Naturgeschichte, pl. iii. f. 11–18, and pl, iv., f. 16–26. 1777.

Terebratula pectinata: BRUGUIERE, Hist. Nat. Vers.; Testacés Encyc. Méthod. pa. 242, plate iv. 1789.

Anomites reticularis: WAHLENBERG, Nov. Act. Soc. Upsal., Vol. viii, f. 65, 66. 1821.

Terebratula affinis: SOWERBY, Min. Con., tab. 324, f. 2. Jan. 1822.

Spirifer sowerbyi: DE FRANCE, Dict., Vol. lx, p. 295, t. lxxvi, f. 2 (valva brachiis spiralibus ornata).

Terebratula (Magas) cancellata: EICHWALD, Zool. i. 276, tab. iv, f. 11.

Terebratulites priscus: SCHLOTHEIM, Nachtragen zur Petrefactenkunde, p. xvii, f. 2. 1822.

Terebratulites explanatus: Schloth., Ibid. pl. xviii, f. 2.
Atrypa reticularis: Dalman Vet. Ac. Handl., pl. iv, f. 2. 1827.
" " Hisinger, Lethæa Suecica, pl. xxi, f. 11.
Terebratula prisca: Von Buch, Ueber Terebratulen, p. 71. 1834.
Atrypa affinis: Sowerby in Murchison's Silurian System, pl. vi, f. 5. 1839.
Delthyris prisca: Fahrenb. in Bull. Mosc., p. 788. 1844.
Terebratula (Atrypa) prisca: Phillips, Figures and Descriptions of the Palæozoic Fossils of Cornwell. Devon and West Somerset, pa. 81, pl. xxxiii, f. 144. 1841.
Terebratula insperata: Phillips, Ibid, pa. 83, pl. xxxiii, f. 18. 1841.
Spirifer affinis: Sowerby, Trans. Geol. Soc. Lond. 2d series, Vol v, pl. lvii, f. 11.
Terebratula prisca: d'Archiac et de Verneuil, Trans. Geol. Soc., Lond. 2d series, Vol. vi, p. 392.
" " A. Roemer, Die Versteinerungen des Harzgebirges, pl. v, f. 11–13. 1842.
" *reticularis:* de Verneuil, Geol. of Russia and Ural Mts., Vol. ii, pl. x, f. 12. 1845.
Atrypa lentiformis: Vanuxem; *A. affinis,* and *tribulis,* Hall, Geology of the State of New York. 1843.
Hipparionyx consimilaris: Vanuxem, Geol. Report of the Third District N. York, p. 132, f. 2. 1843.
Terebratula reticularis: Barrande, Ueber die Brach. Silur. Schichten von Boehmen, pl. xix, f. 8. 1847.
" " Bronn, Index Palæontologicus, p. 1248. 1848.
Spirigerina reticularis: d'Orbigny, Prodrome, Vol. i, p. 99. 1849.
Terebratula prisca: Quenstedt, Handbuch der Petrefactenkunde, p. 461, t. xxxvii, f. 1–4. 1851.
Atrypa reticularis: Davidson, British Fossil Brachopoda, Introduction, Vol. i, pl. vii, f. 87–93. 1853.
? *Terebratula squamifera* pars: Schnur, Dunker und Von Meyer's Palæontographica, Vol. iii, p. 181, f. 4.
" *insquamosa:* Ibid, Vol. iii, p. 182, f. 5. 1853.
" *zonata* [?] Ibid, Vol. iii. p. 182. 1853.
Atrypa reticularis: Morris, Catalogue of British Fossils, p. 132. 1854.
Anomia " Sharpe, in Hanley's "Ipsa Linnæa Conchylia," p. 127. 1855.
Spirigerina " M'Coy, British Palæozoic Fossils, p. 379. 1852.
" " Sandberger, Die Brach. des Rhein. Schichten. in Nassau, pa. 51, pl. xxxiii, f.1. 1851.
Atrypa " Woodward, Manuel of the Mollusca, p. 228, f. 144, 145; and plate xv, f. 21. 1856.
" " Hall, Report on the Geological Survey of Iowa, pl. vi, pp. 4, 5. 1858.
" Hall, Nat. Hist. of New York, Palæontology, Vol. iii, p. 253, pl. xlii, f. 1. 1862.
" " Davidson, Monograph of British Devonian Brachiopoda, part vi, p. 53. 1864.

I have heretofore referred to *Atrypa reticularis* a species of this genus in the Niagara and Lower Helderberg groups, which is allied to, or identical with one of those occurring in the Upper Helderberg and Hamilton groups.

There is, nevertheless, a character of individuality about the forms from each of the geological periods, which serves to distinguish them from each other; and whether this difference shall be recognized as specific or varietal, is perhaps of little consequence at the present time. Taking our collections from the geographical area of New York, we can readily recognize the specimens from each of the successive groups or formations; and I am not

sure that with our present knowledge of their interior characters, it would not be quite as satisfactory to consider them as distinct species.

We may take a line of section from the Lower Helderberg to the Upper Helderberg limestones within the distance of two miles north and south, and where the conditions of the sediments are nearly similar; and we find that the Oriskany sandstone has no representative of the species. The Schoharie grit presents the form of *A. impressa*—but this is distinct from that of the Lower Helderberg limestone, and equally distinct from that of the Upper Helderberg. We have, therefore, three forms which, in collections of hundreds of individuals, do not graduate into each other.

It is true, that tracing the Upper Helderberg limestone five hundred miles to the southwest, we find the form of *Atrypa reticularis* changing; but it does not approximate to that of the Lower Helderberg limestone or of the Schoharie grit, nor do any of these forms resemble the one in the Niagara group.

Several European naturalists, and more recently Mr. DAVIDSON among them (the latter with doubt), have admitted as a distinct species *Atrypa desquamata* of SOWERBY. So far as can be inferred from figures of that species, it corresponds with the *Atrypa* (*Hipparionyx*) *consimilaris* of VANUXEM, a form occurring in our Corniferous limestone, and which we have generally regarded as a variety of *Atrypa reticularis*. At the same time, Mr. DAVIDSON places *Atrypa aspera*, a much more distinct form as I conceive, as a variety of *A. reticularis*.

Without attempting to represent more than a small part of the varieties of form observed in the higher formations, I have endeavored to give a fair expression to those occurring in the Corniferous limestone (Upper Helderberg), Hamilton and Chemung groups.

The specimens figs. 11 – 13, Plate LI, from the Corniferous limestone, illustrate the character of the ordinary form and size of this species as it occurs in New York and Canada West. In these forms the ventral valve is often without mesial sinus or depression, as shown in fig. 11, while it is conspicuous in figure 13. The specimens of this general character seldom reach a much larger size in New York than those above referred to, while in the west we have specimens preserving the same general aspect and character of striæ, with a much more gibbous dorsal valve, and a deep narrow sinus in the ventral valve. Closely allied to these forms is that represented in figs. 4 – 6 on plate 52, where the dorsal valve is extremely gibbous, with the anterior portion elevated in the form of a distinct fold, while the ven-

tral valve is depressed in a broad deep sinus, which is flattened in the bottom and quite unlike the preceding ones in form. This group, represented in figs. 11 – 13, Plate 51, and figs. 1 – 6 Plate 52, is most nearly allied to *Atrypa impressa* of the Schoharie grit, but the specimens do not show the flattening of the middle of the dorsal valve, nor do we know that they have the extremely thickened shell, allowing such depth of the rostral cavity as shown in fig. 8 of Plate 51. This peculiar feature has not been observed in any other of the various forms of ATRYPA obtained from our rocks.

In figs. 10 and 14 – 24, Plate 51, we have the representation of another group of Atrypæ, differing in some small degree from the preceding. In these the young are but moderately convex, broader in form, with the striæ coarser and more regularly bifurcating. So far as observed, they do not acquire the gibbosity of the other forms, the older shells presenting a broad undefined depression of the ventral valve, as shown in fig. 22, but never acquiring the character of a deep or abrupt sinus.

These forms are known in NewYork as occurring in the higher beds of the Corniferous limestone near Williamsville, in Erie county, and are characteristic of the hydraulic beds at Louisville, Kentucky, and Jeffersonville, Indiana.

Continuing the character and mode of development observed in the specimens as represented in the figures referred to, we pass to the forms designated by VANUXEM as *A. consimilaris** (figs. 9 – 12, plate 52), where the front of the dorsal valve is often much elevated and deeply sinuate; the ventral valve has a broad mesial depression, and the front produced. These are the representatives of the European form *A. desquamata.*

The varieties of form in the ventral valve are shown in figures 8, 10, 11 and 12. Figure 9 is a profile view of another individual, and figure 7 is a dorsal view of the same.

The interior of the ventral valve of this form is shown in figure 51.

In a specimen of smaller size than figures 8 and 10, and of similar proportions, we have the muscular and vascular impressions as shown in figure 12. There is really a considerable difference between the parts as shown in this specimen and in the cast of the ventral valve of *A. impressa* as illustrated in figure 9, pl. 1; but there is no important difference between figures 11, 12, except in the proportionally greater length of the muscular impression in the latter.

The common forms of this species in the Hamilton group are illustrated on Plate LIII, figures 3 – 11.

In the young specimens the beak of the ventral valve is elevated and perforated at the extremity, and separated from the umbo of the dorsal valve, the intermediate space being occupied by a deltidium as shown in figures 3, 4. This feature disappears in older shells, and the perforate apex is closely appressed to the umbo of the dorsal valve. The hinge-line is longer and more nearly straight than in specimens from the Corniferous limestone. The dorsal valve does not acquire the extreme gibbosity, and the striæ have a finer aspect. The mesial sinus usually impresses only the front of the shell, and is but moderately developed, consequently affecting only the front of the dorsal valve.

* *Hipparionyx* [*Atrypa*] *consimilaris*, VANUXEM, Report on the Third Geological District of New York, p. 132, f. 2. 1843.

Figures 5 – 7 illustrate the more symmetrical forms of ordinary size.

The interior of the ventral valve shows a large flabelliform muscular area, which is rounded in front and curving to the rostral cavity. Neither in the specimens from this group, nor in those from the limestones below, have I observed any thickening of the parts adjacent to the muscular area, nor any false area, as in those of the Lower Helderberg group. The rostral cavity is usually large and the shell thin; the truncation at the apex is often broad, as if for the protrusion of a strong pedicel. This latter feature may be due to accident; but in separated ventral valves it contrasts strongly with the usual thickening of the parts about the rostral cavity, as observed in the same valves of the Lower Helderberg forms.

In the dorsal valve, as shown in figure 9, we have a well defined muscular area, divided longitudinally by a low septum which becomes thickened in its upper part. The hinge-plate is divided, and presents on each inner margin a tooth-like plate, between which and the crural bases there is a distinct groove. The crura originate close to the apex of the shell and diverge abruptly; the dental sockets are deep in the lower part, and gently curving and narrowing towards the apex. Outside of the socket, and extending along the margin of the shell, is a crenulate callosity, separated from the edge of the shell by a narrow groove.

These features are more fully shown in the enlarged figure 7, of *A. impressa*, and the same, together with the junction of the loop and crura, are shown in the accompanying enlarged figure of *A. reticularis* of the Hamilton group.

ATRYPA RETICULARIS.

Interior of the upper part of the dorsal valve, showing the bases of the crura and connecting loop.

Figures 22 and 23 of Plate 53 A, show the relation of the spires; figure 22 represent these appendages lying in the dorsal valve, and connected at their bases by the loop.

In figure 23 we have the ventral valve mainly removed, showing the dorsal side of the loop and the apices of the spires which are in contact. Each cone presents about twenty-two turns of the spiral band.

In beds referred to the age of the Hamilton group at Independence, Iowa, this species, figs. 14, 15, Plate 53, acquires a large size and presents some peculiarities, particularly in the straight extended hinge and the subcarinate dorsal valve. These features have not been observed in specimens from the Hamilton group of New York, though simulated by some specimens of the Chemung group

as in fig. 19 of Plate 53. The specimen fig. 16, is a ventral valve of a large individual, from beds at Waverly, Iowa, equivalent to those at Independence. It is less extended on the hinge-line, and has been broken so as to show the spires.

Figs. 12 and 13 of Plate 53, are from Lime Creek, near Rockford, Iowa, in beds which are probably of the age of the Chemung group. The specimens are gibbous and finely striated, with strong lamellose lines, and much resemble similar forms from the Chemung group of New York.

This form of ATRYPA becomes a little more robust in the Chemung group, as compared with those of the Hamilton group of New York, but retains generally the same essential characters. Figure 17 is a dorsal view of a specimen from that formation, and figure 18 is the imprint of the ventral valve in shaly sandstone, a common condition of the species in these rocks. Figure 19 is a broader and more finely striate form with straighter hinge-line.

Geological formations and localities.—In the formations under consideration, this species occurs in the Corniferous limestone of New York, Canada West, Ohio, Kentucky, Indiana and Illinois. It is found in the Hamilton group of New York and Canada West; and under an aspect similar to *A. zonata* of SCHNUR, in the Hamilton group of Iowa and Illinois. It occurs in the Chemung group of New York, more especially in the eastern or eastern-central portions of the State, and also in rocks of the same age in Iowa.

Its localities are so numerous that it is scarcely necessary to name them in detail. It is found in nearly every exposure of the Corniferous limestone from Albany county to Black Rock, on the Niagara river. I have received specimens from Mr. JOSEPH SULLIVANT, from Columbus; from Dr. MANN and other sources, collected at Milford, Ohio; from the Falls of the Ohio, by Mr. S. S. LYON; and very fine specimens from Dr. JAMES S. KNAPP, of Louisville. Specimens from Iowa, have been received from Mr. O. H. ST. JOHN, besides collections by Mr. WHITFIELD, myself and others; I have likewise obtained it at the Bake-oven in Illinois, where the Corniferous limestone is intimately connected with calcareous beds of the Hamilton group.

In the Hamilton group of New York, it is not abundant in the arenaceous shales of the eastern counties, but is common on Cayuga, Seneca and Canandaigua lakes; in several localities in the Genesee valley, and at Darien, Eighteen-mile creek, Hamburg, &c., on Lake Erie shore. It is less common in the Hamilton shales of West Williams, Bosanquet and Widder, in Canada West. It occurs at Rock Island in Illinois, at New Buffalo, Independence, and other places in Iowa.

In the Chemung group it occurs on Cayuta creek, Ithaca, Elmira, Painted-post, Bath, etc., but is rare or unknown in the more western localities of that formation within the State of New York.

Atrypa spinosa, vel. A. aspera.

PLATE LIII A.

Atrypa spinosa: Hall, Report on Fourth Geological District of New York, p. 200, f. 1 and 2.

Atrypa dumosa: Id. Ib. p. 271, f. 1.

Comparo *Terebratulites aspera:* Schlotheim (Leonhard's Taschenbuch, pa. 74, tab. 1, f. 7: 1813); Nachtragen Petrefaktenkunde, part 1, p. 363 (95); part ii, 68, tab. 18, f. 3. Also *T. explanata*, idem.

" *Atrypa aspera:* Dalman, Uppst. och Beskrif af de i Sverige funne Terebrat., Kongl. Vetens. Acad. Handlingar, 1827: pa. 128, tab. iv, fig. 3.

" *Terebratula aspera:* De France, Dict. liii, p. 164. 1828.

" *T. reticularis:* Bronn in part, Ind. Palæontologicus, p. 1249. 1848.

" *Atrypa squamosa:* Sowerby, Trans. Geol. Soc. Lond., 2d series, Vol. v, pl. lvii, f. 1.

" *Terebratula (Atrypa) aspera:* Phillips, Pal. Fossils of Cornwall, Devon and West Somerset, p. 81, pl. xxxiii, f. 114. 1841.

" *Spirigerina reticularis*, var. *aspera:* M'Coy, British Pal. Fossils, p. 379.

" *Atrypa reticularis*, var. *aspera:* Davidson, Monograph of British Devonian Brachiopoda, part vi, pa. 57, pl. x, f. 5–8.

Shell robust, suborbicular or oviod; width greater or less than the length; radiatingly costate and concentrically lamellose or spinose; hinge-line often nearly straight, a little less than the width of the shell.

Ventral valve depressed-convex, becoming more convex in the upper part; nearly flat and often a little concave towards the lateral margins, and cardinal extremities depressed or broadly sinuate in front: beak abruptly rounded; apex truncate and perforate, closely appressed and overlapping the umbo of the opposite valve.

Dorsal valve convex, becoming gibbous in old shells, flattened or slightly concave towards the cardinal angles, regularly curving to the sides and baso-lateral margins, and a little elevated in front, but without any distinct mesial fold.

Surface marked by strong rounded radiating costæ bifurcating at unequal intervals, which are much stronger in the middle of the valve, and beeme obsolete or appear as gentle undulations towards the cardinal angles. In the middle of the valves there are about seven or eight of these costæ in the space of half an inch. The shell is also marked by strong concentric lamellæ, which are often about a line apart. In perfect shells these lamellæ, at the crossings of the costæ, are often produced into tubular

spines, which, when worn off, leave the ordinary lamellose surface. The spaces between these projecting lamellæ are marked by fine thread-like striæ.

In the separated valves, the hinge-line is often nearly straight, the muscular area of the ventral valve is short and broad, the length from the apex being about equal to the width. There is a slight thickening of the shell at the base of the rostral cavity. The surface around the muscular area is papillose, and limited by a thickened border, except in front, where it is discontinued. Fine vascular markings are sometimes visible near the margin. In the dorsal valve there is a thickened septum in the upper part of the muscular area.

The spires of full grown individuals about fifteen turns in each.

In casts of this species from the Hamilton group of Maryland and Virginia, we find the same characteristic features preserved as above described.

I have adopted the name *Atrypa spinosa*, although I think this may be identical with the species known as *Atrypa aspera* or *Atrypa reticularis*, var. *aspera*, of European authors; but I wish to preserve for our shell a specific designation. Prof. M'Coy, Mr. Davidson and other European authors adopt the opinion that the variety *A. aspera* passes "by insensible gradations" into well-marked *A. reticularis*. I must insist, however, on a different status for our shell. Passing by the specimens from the Corniferous limestone, where the shells are exfoliated and changed by silicification (rendering discrimination not always so easy), we have only to examine large collections from the Hamilton group to discover a constant and well-marked distinction. I have collected and examined many hundreds of specimens of *Atrypa reticularis*, from various localities of the Hamilton shales in New York, and a smaller number of *Atrypa spinosa*. The former is much the more abundant, and occurs in locality where the latter is not found, though frequently both occur in the same localities, and never for one moment will the collector hesitate as to their distinct specific distinction.

The full-grown shells of *A. spinosa* are proportionally broader and more robust, and from about twelve to twenty-five or twenty-six ribs may be counted on the surface of each valve, according to the size of the shell and the degree of development towards the margin. In specimens of *A. reticularis* of similar size, more than twice as many costæ can be counted, while they do not become obsolete on the

cardinal extremities as in the other species. In *A. spinosa* the beak of the ventral valve is shorter, the hinge-line longer and more nearly straight, the muscular area proportionally shorter, and the adductor imprint comes down lower and is not so clearly pointed. There are also some slight differences in the interior of the dorsal valve; but the specimens examined have been too few and imperfect to render the result satisfactory.

In the character of the internal spires the distinction is quite palpable: the junction of the crura with the valve differs in a small degree, as does the loop and its connection with the crura; while we have about fifteen turns of the spire where there are twenty-two in *A. reticularis* of the same size. The connecting loop does not descend so deeply into the cavity of the valve; and in its junction with the crura, as well as the form of the latter, it differs from *A. reticularis*.

In pursuing investigations to the westward, the contrast between this species and *A. reticularis*, or its representative, continues to be equally or even more strongly marked. In specimens from Iowa, the ribs of *A. spinosa* or *aspera* are stronger and coarser than in specimens from New York; while the form referred to *A. reticularis* has finer striæ and approaches the *A. zonata* of SCHNUR (loc. cit). In collections from the Hamilton group near Cumberland (Md.) and the adjacent parts of Virginia, there are many casts and exfoliated shells of *A. spinosa*, but none of them with the finer costæ, or that can be referred to *A. reticularis*. Although in these species from different localities there is a palpable variation in the number and character of the costæ, the distinction between the two remains as strongly marked as at first indicated.

In the hydraulic limestone beds, which lie mainly above the coral-bearing beds at the Falls of the Ohio; at Columbus and other localities in the State of Ohio, as well as in Western New York, there is a form of ATRYPA which may be considered as intermediate to the *A. reticularis* and *A. spinosa* or *A. aspera*. This form is proportionally broader, less gibbous and more strongly plicated than those which we usually refer to *A. reticularis*—but we do not, in any locality, so far as I know, find these varieties graduating into each other.* These are illustrated on Plate 51, figures 10–24.

* I am not by any means satisfied that this variety may not prove a distinct species, or it may correspond with some of the forms termed *Atrypa aspera* or *A. prisca* of Europe.† It will be observed, in the illustrations on Plate LI, that the form is somewhat different, the ventral valve more expanded,

† The form here referred to resembles two large expanded specimens from Refrath in Germany, received under the name of *Atrypa prisca*.

Figures 1–7, are from the Upper Helderberg limestone.

Figures 8–14, present the ordinary forms and phases of the species in the Hamilton group; figures 8 and 9, retain the spines, and the others have them removed.

Figure 14, is of the interior of a well marked ventral valve.

Figure 18, presents the ordinary phase of this species in the Chemung group. There are sometimes remains of short spines, as shown in the accompanying woodcut.

Figures 24 and 25, show the spiral cones of the interior viewed from the dorsal and ventral side respectively.

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Geological formations and localities.—This species occurs in the Corniferous limestone, in nearly all the localities cited for *A. reticularis.* In the Hamilton group, its principal localities are Moscow and York in Livingston county, Darien in Genesee county, Hamburgh and Eighteen-mile creek in Erie county; likewise on the shores of Seneca and Cayuga lakes, and eastward of these points. It occurs in the same formation in Maryland and Virginia, in Canada West, and in Iowa and Illinois. In the Tully limestone, it is found at Tinker's falls, Onondaga county, New York. In the Chemung group, it occurs in considerable numbers on Cayuta creek at Factoryville; at Chemung, Chemung creek and Chemung-narrows, and at Bath and vicinity; also at Elmira and northward of that place. It becomes rare or altogether unknown in the southwestern counties of this State.

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and the costæ coarser than in the Hamilton and Chemung specimens of *A. reticularis;* but these distinctions cannot be fully illustrated till we know more intimately the structure and character of all its parts. While these pages are going through the press, I have examined more than a hundred specimens of this form and of the finely costate species, and find no difficulty in separating them one from the other though there are remarkable variations in individuals. In making the comparisons and references to *Atrypa reticularis,* I have adopted that name for the more finely costate forms, but I am compelled to express some doubt whether we fully understand the original of that species. After much careful study of the interiors of several genera of Brachiopoda, including ATRYPA, I still hesitate to accept the general opinion regarding a species which is so well known, and is found abundantly in all the formations from the Devonian to nearly the bottom of the Silurian system, and which has received the following appellations:

Anomites reticularis, WAHLENBERG, Nov. Act. Soc. Upsal, Vol. viii, p. 65.

Terebratulites priscus, SCHLOTHEIM, Petrefact., Pl. lxxxvii, f. 9.

Terebratula affinis, SOWERBY, Min. Conch. Pl. cccxxiv, f. 2, etc., etc.

If this, in all its phases, be a single species, there are many of the species designated under other genera of Brachiopoda, which have no better claim to specific value, subject to the same rule.

Atrypa hystrix.

PLATE LIII A.

Atrypa hystrix: HALL, Report of Fourth Geological District, p. 272, f. 2; p. 271. 1843.

SHELL suboval, ovate or subcircular, usually flattened: surface acutely costate.

The shells of this species are too imperfect and obscure to admit of detailed description. The valves are usually much flattened, and the imprints are left in shaly sandstone or shale from which the shell has been removed. The surface is marked by a few distant angular or subangular ribs, which are sometimes bifurcated, and are crossed by strong lamellose striæ. In the perfect shell, long spines proceed from the lamellæ at the crossing of the ribs; and when the shell is exfoliated, the ribs are nodose from the spine-bases.

The collections furnish a single gibbous specimen of the dorsal valve, one inch and a quarter long by about an inch and a half wide, with a depth of about three-fourths of an inch, and other specimens of smaller size.

The young specimens of *A. spinosa* approach this form, as shown in figure 8 of Plate LIII A, and it is possible that this may be an extreme variety of that species. The specimens, figures 16 and 17, occur in localities where forms like figure 18 are found, but there are no palpable gradations; and among a hundred individuals like figure 18, and figure 1 of page 325, there is no deviation which can be regarded as an approach to figures 16 and 17.

Geological formation and localities. This species is known only in the middle and higher part of the Chemung group, and has been principally found to the south and southwest of Bath in Steuben county.

*** From collections recently made in Iowa, we learn that in all localities the distinction between *Atrypa reticularis* and the associated species is more strongly marked than in the collections from New York, and there is nowhere any indication of gradation from the one to the other. In the higher beds of the series in Northern Central Iowa, which may be of the age of the Portage or Chemung formation of New York, the species identified with *A. reticularis* is more finely costate, while the other form approaches more nearly to the *A. hystrix* of our rocks having a few coarse plications with spines; these appendages, however, are rarely preserved.

Atrypa pseudomarginalis.

PLATE LIII.

Atrypa pseudomarginalis: Hall, Thirteenth Report on the State Cabinet, p. 84. 1860.

Shell trilobate, wider than long; surface plicated.

Ventral valve depressed-convex, gently curving to the sides; mesial sinus deeply depressed in the lower part, and extending for more than two-thirds the length of the shell; beak extending beyond that of the dorsal valve and moderately incurved.

Dorsal valve regularly convex above, curving somewhat abruptly to the sides; the mesial fold becoming conspicuous at about one-third the length from the beak and rising into a prominent rounded lobe, which occupies more than one-third the width of the shell in front.

Surface marked by numerous rounded bifurcating plications.

This species resembles *Atrypa marginalis* of Dalman, but is larger and more robust than the specimens of that species which I have seen: the beak is less attenuate, the mesial fold and sinus broader and not extending to the beak, and the striæ coarser and not so much recurved. From the Bohemian specimens under the same name, it differs in the greater elevation and rounded form of the mesial lobe, and the less angular plications. It has proved extremely rare in the rocks of New York.

Geological formation and locality. In the Upper Helderberg limestone at Schoharie, New York.

Genus Cœlospira (Hall).

The species published under the name of *Leptocœlia concava* in the third volume of the Palæontology of New York, page 245, was subsequently found to possess internal spires, arranged in a somewhat peculiar manner, and connected by a strong loop. This feature rendered it necessary to remove the fossil from the association in which I had placed it, with *Leptocœlia imbricata* and *L. flabellites*, and I have proposed for it the generic name Cœlospira.*

This genus differs but little from Zygospira proposed by me in 1862,† and it may be found desirable to unite the two under that designation, extending the characters so as to include the types of both the genera; but this can only be done after the discovery and examination of other species which may serve to unite the forms already described.

The shells of Cœlospira are concavo-convex, having the ventral valve convex or sometimes subangularly arching over the concave dorsal valve. The surface of the shell is striated or plicated, with the plications simple or bifurcating, and of which two or more in the centre of the ventral valve are more conspicuous than the others, forming a more or less defined mesial fold; upon the dorsal valve there is a corresponding depression. The space between the valves leaves little room for the spires, and these appendages appear to be somewhat loosely arranged, with their apices approaching each other. These shells are apparently fibrous in texture; and on this account, and from the position of the spires, they approach more nearly to Atrypa than to Trematospira, to the latter of which they are more nearly allied in external form.

The *Terebratula barrandi* of the Wenlock limestone of England belongs apparently to the genus, being closely allied to *C. disparilis* (= *Atrypa disparilis*) of the Niagara group (Palæontology of New York, Vol. ii, p. 277), holding likewise a similar geological position.

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* Sixteenth Report on the State Cabinet, p. 60. 1863.

† Fifteenth Report on the State Cabinet, p. 154. 1862.

Cœlospira concava.

PLATE LIII.

Leptocœlia concava : HALL, Pal. New-York, Vol. iii, pa. 245, pl. xxxviii, figs. 1–7. 1861.

Cœlospira concava : HALL, Sixteenth Report on the State Cabinet, p. 60, with figure. 1863.

The specimens from the Upper Helderberg limestone at Caledonia, New-York, and those from the upper portion of the Lower Helderberg group in Oneida and Herkimer counties, do not show any differences of specific importance, and I am therefore constrained to regard this species as passing upwards from the Lower Helderberg formation; unless indeed we may infer that some of the sediments of that epoch may have extended farther to the westward and this species have there existed, while the superincumbent formations of limestone, in the absence of the Oriskany sandstone, have directly succeeded the older beds in such a manner as to have become incorporated with them, or to have left no line of demarcation.

A single specimen from Stafford in Genesee county is considerably larger than any of those from other localities of the Corniferous limestone or of the Lower Helderberg group, while the sinus of the dorsal valve is narrower and less depressed. The material at present possessed is insufficient to characterize it as a distinct species.

Geological formation and localities. In the Corniferous limestone at Caledonia and other places in Western New-York, and also in the same formation in Canada West.

The accompanying figures illustrate the interior of CŒLOSPIRA and ZYGOSPIRA :

1. 2. 3.

Fig. 1. A view of the spires in CŒLOSPIRA CONCAVA from the ventral side.*
Fig. 2. A view of the same from the dorsal side.
Fig. 3. A view of the spires of ZYGOSPIRA from the ventral side.

The Genus UNCITES, which is characteristic of the European Devonian system, has not occurred among the collections made in the State of New-York, and so far as I know is not found in this country. Of the six genera of SPIRIFERIDÆ enumerated in the preceding pages, which do not occur in Mr. DAVIDSON's list, five of them are likewise known in the Silurian formations of this country. The Genus MERISTA, which is cited as occurring in the Devonian of Europe, is not known in our strata of the same age ; and it is possible that the European forms of that geological period may present the same modifications as with us, and fall under the Genus MERISTELLA. Although not recognizing the Genus RETZIA, which in Europe is characteristic of the Silurian and Devonian stages, we have in TREMATOSPIRA and RHYNCHOSPIRA two allied genera. The other genera of this family enumerated in Mr. DAVIDSON's list are characteristic of more modern formations than those from which species are here described.

* The disposition of the spirals in CŒLOSPIRA is not very dissimilar from the same appendages in KONINCKIA, a Triassic genus of Brachiopoda.

FAMILY RHYNCHONELLIDÆ.

The Rhynchonellidæ are distinguished from the Spiriferidæ mainly by the absence of calcareous spires; though Mr. Woodward includes Atrypa in this family, remarking that the teeth and impressions are like Rhynchonella, and that "the shells of this genus differ from Rhyncho-"nella chiefly in the calcification of the oral supports, a character of "uncertain value." Mr. Davidson and other authors have placed Atrypa in the family Spiriferidæ, and I see no reason for changing this disposition of the genus. The spires are in all respects similar to those of Spirifera, the direction of their apices into the dorsal valve being simply a feature of position. The muscular imprints are as much like those of Spirifera as they are like Rhynchonella.

Leaving out the Genus Atrypa, the Family Rhynchonellidæ will include no genus with calcareous spires; but from analogy with modern Rhynchonella, they are supposed to have possessed fleshy spiral arms which have not been preserved in the fossil state. This family, in its usually accepted limitations. will include Rhynchonella (as at present understood), Stenocisma, Leiorhynchus, Camarophoria, Pentamerus, and Stricklandinia; though I think there would be great propriety in uniting the two latter genera with some others in a separate group.

Genus Rhynchonella (Fischer, 1809).

The species *Rhynchonella loxia* is made the type of this genus by its author. It is only within a recent period that the name has been so extensively applied to nearly all the ovoid or subtrigonal plicated, and some smooth shells of all geological epochs, from Lower Silurian to the most recent formations, and it has been recognized in two existing species.

In the Introduction to the Study of the Brachiopoda (page 95 of the English edition, page 117 of the French edition), Mr. Davidson remarks: "The Genus Rhynchonella is one of the oldest types of animal life, "having been repeated from the Silurian epoch up to the present period: "two species are still found alive."

I have heretofore accepted the general views of palæontologists regarding this genus, and have described a number of species under it; but I have long been satisfied that in making such extensive application of the term Rhynchonella, we were in danger of falling into an error of scarcely less magnitude than that of referring all similar forms, with many others, to the Genus Terebratula.

Unfortunately the internal characters of *R. loxia* do not seem to be known: at least I have not seen them illustrated; and though cited as the type by Mr. Davidson, and figured upon the plate, it is not enumerated in his list of eighteen examples. Mr. Woodward gives as types *R. acuta*, *furcellata*, *spinosa*, *acuminata*, *nigrescens* and *psittacea*; species enumerated in Mr. Davidson's list, but he does not cite *R. loxia*.

With the interior structure of the type of the genus unknown, while the parts are illustrated from recent species, or from fossil ones *supposed* to belong to the genus, we are not likely to make satisfactory progress in the arrangement of the fossils usually referred to it. A careful study of those fossils which have been cited as examples of genera, passing through all the geological stages and still existing, has proved, in some of them at least, that the assumption was not well founded; and I think

we should hold such views with reservation. In the present instance, I must be allowed to doubt whether *R. loxia* will be found to possess the characters of Lower Silurian and of existing RHYNCHONELLÆ; nor do I consider the characters of the existing species as congeneric with those of the older Silurian or Devonian formations. The necessity felt for some other designation to apply to some of these forms has induced the names *Hypothyris*, *Hemithyris*, *Cyclothyris*, etc.; but these do not appear to have been founded on reliable structural characters. That some subdivision will become necessary, and will be adopted, I have no doubt; but such a desirable end can only be consummated after the study of the interiors of numerous specimens, with large collections for comparison.*

Although having adopted the name RHYNCHONELLA for our Devonian species, I have lately observed characters which appear to me to separate them so widely from the recent species of the genus, that I am compelled to substitute some other designation.

Among genera of the same family, we must necessarily make distinctions upon the modifications of certain parts which they may all possess in common; and the importance of these modifications of interior parts or appendages should not be overlooked. Not only do the recent and fossil forms referred to RHYNCHONELLA possess great similarity in the ventral valve, teeth and dental plates, but they are not very dissimilar from the same parts in genera of the SPIRIFERIDÆ. It is in the dorsal valve and its appendages that we find characters the most important and reliable for generic distinction; and it is only necessary to follow these in the genera of the TEREBRATULIDÆ and SPIRIFERIDÆ, to recall the most curious and interesting modification of the parts which this valve supports. I am therefore inclined to regard these modifications of generic importance.

In many of the fossil species referred to RHYNCHONELLA, one of the most conspicuous features in the dorsal valve is the strong septum, which becomes broader and often shows indications of division at the apex, or at least evidence of a small and shallow V-shaped pit.

* The reliance upon external forms for the determination of generic affinities or differences, although a compulsory condition in many instances, is far from satisfactory. As an example of this kind, I may remark that having recently occasion to compare *Terebratula sappho*, BARRANDE, with *Rhynchonella sappho*, HALL, the former presented so much of a rhynchonelloid aspect as to suggest the propriety of regarding the latter as a synonym. A careful examination of the Bohemian species, from cutting down the solid fossil, has revealed the fact that it is furnished with calcareous spires arranged as in ATRYPA, the spires directed into the cavity of the dorsal valve, and the crura connected by a loop in a similar manner.

The recent species of RHYNCHONELLA do not certainly furnish any evidence of similar characters, so far as I have been able to examine specimens or illustrations. The dental plates of the ventral valve are not, it is true, essentially different in fossil and recent RHYNCHONELLA; but the same comparison may be made with other genera even out of the Family RHYNCHONELLIDÆ.

With these facts before us, I propose to revive the name STENOCISMA* of CONRAD for the species under consideration, extending the term to include the typical species *Rhynchonella formosa* of the Lower Helderberg group. This genus may be characterized as follows :

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* In his second Annual Report (page 59, 1839), Mr. CONRAD, speaking of the rocks of New-York, says : "The Genus TEREBRATULA is wholly unknown, and the shells usually referred to that genus " I propose to group under the generic name of STENOCISMA, derived from two Greek words signi- " fying narrow fissure, a character these shells possess under the imperforate apex of the larger " valve, and which serves to connect the genus with DELTHYRIS, from which it differs in having no " cardinal area. This last-named character, on the other hand, connects it with the Genus STRYGOCE- " PHALUS. I refer to it the common Silurian bivalve, *Terebratula schlotheimii*, VON BUCH."

Notwithstanding the assertion of imperforate apex, we have learned that many of these forms, and probably all those which have been referred to TEREBRATULA, have had at some period of their growth a perforate apex. It was also a Lower Helderberg species (*Rhynchonella formosa*) which was referred by Mr. CONRAD to "the common Silurian bivalve *T. schlotheimii*." I have in my possession a lithographed plate of the fossils of the Lower Helderberg group by Mr. CONRAD, with the names, in his own hand, written beneath the figures; the species I have since designated as *R. formosa* having there been identified with *Terebratula schlotheimii*.

Although the generic characters were not fully described, and with imperfect reference to species, I think it preferable to adopt this name instead of introducing a new one.

The name HEMITHYRIS, applied by some authors to certain rhynchonelloid forms, has been used to include very heterogeneous materials; and without citing a long list to prove this, I may mention *H. angustifrons*, M'COY, *H. subundata*, M'COY; *H. hemisphericа*, var. *scotica*, M'COY; all figured on the same plate, and belonging to three distinct genera; the first named being undoubtedly a MERISTELLA, and having internal spires. This generic term, therefore, cannot be adopted unless redefined and very much restricted in its application.

Genus or Subgenus Stenocisma (Conrad—Hall).

Shells subtriangular, ovoid or subglobose; hinge-line short : beak of ventral valve extended, attenuate or more or less arcuate and appressed against the opposite valve. A mesial sinus and fold on the ventral and dorsal valves respectively. Surface plicated with simple or rarely bifurcating plications.

The valves are articulated by teeth and sockets. A strong median septum in the dorsal valve of many of the species, which becomes thickened in its upper part, with a shallow triangular pit in the centre, and the crura supported on each side : dental sockets crenulate. The teeth are strong, with lamellæ extending to the bottom of the valve, limiting the rostral cavity, and sometimes partially surrounding the muscular area.

In casts of the ventral valve, the cavities made by the diverging lamellæ are very distinct; and in the dorsal valve, the place of the septum is strongly marked, the space being wide above, and within this cavity at the upper part there is a small angular elevation of greater or less extent, which originally filled a depression in the upper part of the septum.

I would by no means include all the palæozoic so-called Rhynchonellæ under this genus, for I am satisfied that there are plicated shells of similar form which have a different internal structure ; but it is absolutely necessary that this structure be known, before we can make a proper disposition of the species.

Rhynchonella (Stenocisma) tethys.

PLATE LIV.

? Rhynchonella tethys : Billings, Canadian Journal, p. 270. 1860.

Shell subtrigonal ovate, usually wider than long, sometimes length and width equal.

Ventral valve depressed convex in the upper part, nearly flat at the sides : mesial sinus beginning above the middle, moderately depressed in young shells, and in older ones becoming deep in front and abruptly curving towards the dorsal valve.

Dorsal valve moderately convex in young shells, more convex and finally gibbous in old shells: the broad mesial elevation becoming distinct about the middle of the length.

Surface marked by from fifteen to eighteen angular plications of which five or six are upon the mesial fold and sinus, and about an equal number, or sometimes six or seven, on each side: the plications on the dorsal valve near their extremities curve very abruptly to the ventral valve. Fine concentric striæ, which are undulated in crossing the plications, mark the surface of the shell; but this feature is rarely preserved.

Some specimens from the Corniferous limestone of Western New-York appear to be of this species, but they are smaller than the figures of Mr. Billings. A single large specimen from Port Colborne, Canada West, has five plications in the sinus and six on the fold, with seven on each side.

I have received from Dr. Knapp of Louisville several fine specimens from the limestone of the Falls of the Ohio, which I have referred to this species: one of these has a length of eleven-sixteenths of an inch, with a width of nearly twelve-sixteenths and a depth of half an inch. In another, the length, width and depth are as 8, 10 and 5 respectively. A young individual has three plications in the sinus and five on each side; while a smaller one has but two plications in the sinus. I have been inclined to believe that this is only a different condition of *S. sappho* of the Hamilton group.

Geological formation and localities. This species occurs in the Corniferous limestone, at Stafford, Genesee county, and Williamsville, Erie county, New-York; at the Falls of the Ohio; at Port Colborne and elsewhere in Canada West.

Rhynchonella (Stenocisma) billingsi (n. s.).

PLATE LIV.

Rhynchonella thalia: Billings, Canadian Journal, p. 272. 1860.
Not *R. thalia*: D'Orbigny. 1847.

Shell small, ovoid subtrigonal, truncated in the middle of the front and rounded on each side; width greater than the length.

Ventral valve moderately convex; mesial sinus beginning a little above the middle of the length of the shell, and marked by "three simple, acutely angular ribs"; beak elevated and acute.

Dorsal valve convex; mesial fold beginning above the middle of the valve, and becoming prominent towards the front.

Surface marked by about seventeen or eighteen sharply angular plications on each valve, of which three are in the sinus and four on the mesial fold; concentrically marked by fine abruptly undulating striæ.

The specimens which I have examined and referred to this species are somewhat smaller than those figured by Mr. Billings. I am not quite satisfied that the species is distinct from *R. horsfordi* of the Hamilton group; but specimens of the latter of the same size have a greater number of plications on the fold and sinus, and the shell is larger. Should it prove a distinct species, the name *thalia*, being preoccupied, must give way to another.

Geological formation and localities. In the Corniferous limestone of Western New-York and Canada West.

Rhynchonella (Stenocisma) carolina (n. s.).

PLATE LIV.

Shell ovate, moderately gibbous, a little produced in front and broadly sinuate; length and breadth about equal.

Ventral valve convex in the upper part, curving gently to the margins and a little concave along the cardinal slope, sometimes nearly flat below; beak little incurved or nearly straight; sinus beginning at about one-third the length of the shell from the apex, very gradually depressed and not abruptly incurved in front, making a broad shallow sinus with curving sides, the limits of which are not strongly defined.

Dorsal valve moderately gibbous and regularly arcuate from summit to base, the sides more abruptly curved; mesial fold becoming defined above the middle of the shell, its summit convex and the sides not abruptly limited.

Surface marked by about twenty to twenty-five obtusely angular plications; those of the margins becoming obsolete and about four or five depressed in the sinus, with a corresponding number on the dorsal fold, which are stronger than the rest; a single one on each side of the sinus

and fold, partially depressed or elevated, and smaller than the others. The shell has been marked by elevated thread-like concentric striæ.

The specimens described are essentially casts, the shell being partially preserved on one of them. The species differs from all the other rhynchonelloid forms of the limestone, in the broad scarcely defined sinus, which is not abruptly elevated in front; and in the undefined margins of the fold, which are marked on the slope by a less strongly raised plication. The beak is also more extended than in the other species.

In casts of the ventral valve, there is no important distinction between this and other forms in regard to the dental plates, etc.; but I am induced to believe that investigation upon more extensive material will prove the characters of the dorsal valve to be so far distinct as to require generic separation.

Geological formation and localities. In the Corniferous limestone at Sandusky, and near Columbus, Ohio.

Rhynchonella? (Stenocisma?) royana (n. s.).

PLATE LIV.

Shell ovate, compressed; beaks nearly equal: valves almost equally convex above; the dorsal valve continuing in a pretty regular convexity, and the ventral valve depressed in a broad undefined sinus.

The surface is marked by about twenty-four or more slender plications on the margin, the three or four central ones on the dorsal valve bifurcating once above the middle of the shell, and some of them again below the middle: the same feature is more or less characteristic of the ventral side. The plications upon the sides of the shell are simple and become obsolete on the cardinal slopes, which are marked only by concentric striæ. When perfect, the entire surface has been marked by fine concentric striæ.

The hinge-line presents obscure indications of an area on the ventral valve, and the species is unlike anything else known in the formation. It cannot be referred with certainty to any known genus. It is extremely rare, and but a single individual has been found.

Geological formation and locality. In the Corniferous limestone, north of Leroy, New-York.

Rhynchonella (Stenocisma) horsfordi.

PLATE LIV.

Rhynchonella horsfordi : HALL, Thirteenth Report on the State Cabinet, p. 87. 1860.

SHELL, in full-grown specimens, transversely subelliptical; rostral portion sometimes a little extended; front nearly straight or broadly rounded; length and width about as five to six or seven. Young shells ovoid subtrigonal.

VENTRAL valve moderately convex, flattened and incurved in front; a slightly depressed sinus, appearing about the middle of the length, which is flat in the bottom and curving abruptly upwards in front: beak moderately extended, abruptly acute and usually but little incurved.

DORSAL valve very gibbous in old shells, sloping abruptly to the beak; depressed-convex in young shells. Mesial elevation defined below the middle of the length.

SURFACE marked by about fifteen or sixteen to twenty-four well-defined angular plications, of which four to six or seven mark the mesial sinus and fold, which are deeply bifurcated in front. On the sides and towards the cardino-lateral margins of the shell the plications are less angular : concentrically marked by fine undulating striæ, which are seen towards the front, but rarely on other parts of the shell.

The size varies from a quarter of an inch in length and five-sixteenths in width to nine-sixteenths in length and thirteen-sixteenths of an inch in width, according to age.

A specimen of half an inch in length from the limestone of the Falls of the Ohio, sent to me by Dr. KNAPP, which I refer to this species, presents a strong interrupted line of growth above the middle, and has about twenty-eight plications visible, of which four mark the sinus and five the mesial fold.

This species differs from the *R.* (*S.*) *sappho* in the finer, more numerous and more angular plications; and is usually a much smaller shell. It can scarcely be compared with any of the devonian forms of Great Britain, having only a remote

resemblance to *R. primipilaris* or *implexa*. It is never abundant, and is often found in a crushed and distorted condition.

Geological formations and localities. In the Hamilton group, at Moscow, York, Genesco and elsewhere in Western New-York; also in the Marcellus shale at Avon and other places.

Rhynchonella (Stenocisma) sappho.

PLATE LIV.

Rhynchonella sappho : HALL, Thirteenth Report on the State Cabinet, p. 87. 1860.

SHELL, in full-grown individuals, transverse, gibbous, subelliptical. Young shells broadly subtrigonal, becoming short-ovate; nearly straight in the middle of the front, abruptly pointed at the beak : cardinal slopes concave; sides rounded to the mesial fold and sinus.

VENTRAL valve flabelliform, depressed-convex, rarely a little gibbous on the umbo, flattened and depressed in the middle towards the front; the sinus becoming perceptible about the middle of the length : sides nearly flat; apex abruptly acute, and more or less incurved according to age.

DORSAL valve gibbous, regularly arching transversely; the mesial fold becoming conspicuous only towards the front : in young shells only moderately convex.

SURFACE marked by twenty to twenty-two or twenty-four plications (fourteen or fifteen in the young shells), those towards the cardinal margin less elevated; about four to six mark the sinus and fold. In old shells, the plications are grooved towards the front; and those of the sides of the dorsal valve are very abruptly bent towards the ventral valve, with a shorter and wider groove, and all deeply bifid for the reception of the opposite plication. The shell is concentrically marked by fine thread-like elevated striæ, which are more conspicuous and strongly undulating towards the front of the shell, their remains being often preserved in the casts.

Length and width, in full-grown shells, as seven to eight.

This beautiful and symmetrical species differs from *R. horsfordi* in its more robust character and stronger plications. It may be compared with the *R. flexistria* = *R. tumida* of PHILLIPS, a Devonian species of Europe.

Geological formation and localities. From calcareous layers in the Marcellus shale near Leroy, Genesee county; also in the Hamilton shales at Geneseo and York, Livingston county; and at Eighteen-mile creek in Erie county. A specimen received from Rev. E. J. BUSH was obtained in the vicinity of Hamilton in Madison county, New-York.

Rhynchonella (Stenocisma) congregata.

PLATE LIV.

Atrypa congregata : CONRAD, Annual Report on the Palæontology of New-York, p. 55. 1841.

SHELL robust, varying from short-ovate to subglobose; length and width nearly equal or a little wider than long; front rounded or straight in the middle; apex pointed.

VENTRAL valve convex at the sides, depressed in the middle; mesial sinus often beginning at about one-third the length from the apex, and becoming conspicuous towards the front : beak, in old shells, closely arcuate over the apex of the opposite valve; in young shells, nearly straight or slightly incurved.

DORSAL valve gibbous in old shells, regularly convex in young specimens : mesial fold scarcely conspicuous on the upper half of the shell, sometimes prominent near the margin; sides curving abruptly to the junction with the opposite valve.

SURFACE (in young shells) marked by only nine or ten distinct subangular or rounded plications; in older shells, by eighteen to twenty-two, of which three or four occupy the mesial sinus and four or five the mesial fold. In the two larger specimens observed, there are but three plications in the sinus, and this is the prevailing number. Slender concentric striæ, sometimes a little imbricated in front, mark the surface of the shell.

Casts of this species are more common than the shell; and those of the ventral valve show the dental plates reaching to the bottom of the

cavity, and margining the upper part of the muscular area, which is often distinctly limited by the rostral cavity. In the dorsal valve there is a distinct septum reaching half the length of the valve, its inner upper edge partially divided, and leaving an angular prominence which has been the filling of the depression in the septum.

The surface plications appear to be more angular in specimens from the arenaceous beds; and the casts of the interior of some specimens, which I have referred to this species, present distinctly angular plications.

This species is readily distinguished from *R.* (*S.*) *sappho* by its more rotund or ovoid form and more rounded plications. The ventral valve is more convex, and never so flat at the sides; while the ends of the plications, curving upward to meet the margin of the dorsal valve, form a distinctive feature, apparent in the profile views. In this respect, it bears more resemblance to some of the rotund forms of the Lower Helderberg group, as for example the *R. pyramidata*.

In some of its conditions as casts in a ferruginous argillaceous sandstone, this species bears much resemblance to the *R.* (*S.*) *contracta* of the Chemung group; but that species is never so rotund, the sinus is deeper, and the plications are angular.

Mr. Conrad's description of *Atrypa congregata* is as follows: "Suborbicular, "with about fifteen rounded costæ crossed by wrinkled lines; lesser valve with "the central part flat, slightly elevated, except towards the base, where it is more "prominent, wide at base and rapidly narrowed above, with four flattened ribs; "inferior valve with a regularly concave depression in the middle. *Locality.* Conk-"lin's Falls, near Apulia, Onondaga county."

This species is spoken of as "the most abundant fossil in a formation of shale" (Table of formations, No. 22); and since the above described species of Rhynchonella is the only one which is at all common in the neighborhood of the locality named, I have referred it to Mr. Conrad's species.

Geological formations and localities. In the condition of casts of the interior, this species occurs abundantly in some calcareo-arenaceous or partially shaly bands of the Hamilton group, near Fultonham and Summit in Schoharie county, at the Unadilla forks in Otsego county and near South Onondaga. It is found in the Tully limestone near Tinker's falls. A single specimen, of small size, is from a calcareous band in the Hamilton group at Alden in Erie county.

I have received several very good specimens from Rev. E. J. Bush of Hamilton in Madison county.

Rhynchonella (Stenocisma) prolifica (n. s.).

PLATE LIV.

Shell subtriangular-ovate; length and width about equal : front rounded, with a shallow sinus and gentle elevation, depressed in young shells and becoming gibbous in older ones.

Ventral valve depressed-convex in the middle, elevated or a little gibbous on the umbo, curving to the sides and gently depressed in a shallow sinus below the middle : apex slightly incurved.

Dorsal valve equally convex with the ventral, sometimes a little more convex, the difference increasing with age; regularly convex as far as the middle of the shell, below which the mesial fold becomes more or less elevated, but rarely rises conspicuously above the general outline.

Surface marked by about twenty to twenty-two, sometimes twenty-four angular plications, of which three occupy the mesial sinus and four the mesial fold. Sometimes a few imbricating lines of growth are visible, but the finer surface markings are unknown.

Length usually less than half an inch, and few individuals exceed this.

The casts of the interior show short and rather slender lamellæ in the ventral valve, and a short septum in the dorsal valve.

This species is a very common one in the eastern part of the State, usually occurring in the condition of casts of the interior. It is distinguished by its slender angular or subangular ribs; the shallow sinus which is gently curved upwards in front, and the nearly straight or little curved beak, while the length and breadth are usually about equal in young specimens.

In young specimens there is no perceptible sinus, and sometimes but sixteen plications visible. Some very young specimens from the western part of the State, which may be of this species, have only about twelve plications. Specimens from the Hamilton group of Iowa, received from Mr. O. St. John, are of very similar character to those of New-York, but with more elongate beak.

Geological formation and localities. This species occurs abundantly in some compact beds in the shales of the Hamilton group, near Fultonham in Schoharie county; and is equally or more abundant in some decomposing ferruginous beds near Cooperstown in Otsego county. Small individuals (which I have referred to this species in its young state) occur at Moscow and York in the Genesee valley, and elsewhere in Western New-York.

Rhynchonella (Stenocisma) dotis (n. s.).

PLATE LIV.

Shell subtriangularly ovate, wider than high, rounded in front, or sometimes truncate in the middle; a shallow mesial depression and moderate elevation in front.

The dorsal valve is more or less gibbous, and the plications at the sides are curved abruptly to the margin of the ventral valve.

The plications are subangular or rounded, and about eighteen may be counted in the larger individuals. The surface has been marked by fine concentric striæ, and one or two imbricating lines of growth near the front.

In two partial casts the plications are subnodose at the junction of these imbricating lines, where they are abruptly incurved on the margins.

The largest specimen observed has a width of half an inch, with a length of seven-tenths and a depth of one-quarter of an inch.

This shell resembles the preceding one in its general outlines, being proportionally a little wider : the ventral valve is a little more flattened on the sides, the ends of the plications not so much curving to the dorsal valve, and the sinus curving more abruptly in front. The beak is very slightly incurved.

Geological formation and localities. The most characteristic specimens of this species have been found in a calcareous layer in the upper part of the Hamilton group, at Eighteen-mile creek on Lake Erie; and others from Geneseo and York in Livingston county, New-York.

Rhynchonella (Stenocisma) carica (n. s.).

PLATE LIV.

Shell round-ovate; length and width about equal, rounded in front.

Ventral valve moderately convex above the middle, curving gently to the lower lateral margins and abruptly to the cardinal slope, regularly

arcuate from beak to base along the gently depressed mesial sinus, which bears four plications in the bottom, and one on each side partially included, giving it an undefined outline.

Dorsal valve gibbous, somewhat regularly convex in the middle and upper part, and interrupted only on the lower third by the moderately elevated mesial fold; the plications on the lower lateral margins strongly curving to the edge of the ventral valve.

Surface marked by about thirty subangular plications on each valve; of which four and partially a fifth are depressed in the sinus, giving five prominent and a sixth less elevated on the mesial fold. The finer markings are not preserved in the specimen examined.

From a partial cast of the apex of the ventral valve, it appears to have had short dental lamellæ.

This species bears much resemblance in its general form to *R.* (*S.*) *carolina* of the Corniferous limestone; but it is more rotund, the sinus less wide and not reaching so far towards the beak, the plications less angular and more numerous. I have a single specimen only, received from Rev. E. J. Bush, and this one has the appearance of being an adult shell, measuring nearly three-fourths of an inch in length and having about the same width.

Geological formation and locality. In the Hamilton group, near Hamilton, Madison county, New-York.

The following species from the Tully limestone is given in this connexion on account of its geological position and relations, although it does not appear to me to be quite congeneric with the preceding and following species. Leaving it under the Genus Rhynchonella for the present, I nevertheless believe that when its internal characters shall be fully known, this one and a few others will constitute a distinct genus. In its young condition this species has much the aspect of Leiorhynchus, and might readily be mistaken for a species of that genus.

Rhynchonella venustula.

PLATE LV.

Atrypa cuboides : Vanuxem (non Sowerby), Geol. Report Third Dist. New-York, p. 163, f. 1.
" " ? Hall, Geol. Report Fourth Dist. New-York, p. 215 and 216, f. 1.
Compare *Atrypa cuboides* : Sowerby, Geol. Transactions, 2d series, Vol. v, pl. lvi, f. 23.
Also " " Philips, Palæozoic Fossils of Cornwall and Devon, pa. 85, pl. xxxiv, f. 150.
Also *Terebratula crenulata* : Id. ib. p. 85, f. 152.
Also *Atrypa subcuboides*, D'Orbigny = *A. cuboides*, Philips (non Sowerby), Prodrome, Vol. i, p. 93, n. 884.

Shell in the young state oval or ovate, with a moderate or scarcely perceptible sinus, and few or no plications except upon the middle of the shell; becoming gibbous, rotund or subcuboid, with the width a little greater than the length, and the depth from two-thirds to three-fourths as great as the length, with a deep sinus and the surface entirely plicated; cardinal line extending for two-thirds or three-fourths the width of the shell.

Ventral valve in young shells a little less convex than the dorsal, and moderately or scarcely at all depressed in the sinus. In older shells the ventral valve is moderately convex in the middle above, and abruptly depressed in the broad deep sinus, while it is flat or concave towards the lateral margins. Umbo moderately elevated, with the beak minute and closely appressed. The cardinal margins are often so abruptly incurved as to give the appearance of a narrow area on each side of the apex.

Dorsal valve in young shells a little more gibbous than the opposite, and without defined mesial elevation; becoming more gibbous with the growth of the shell. In full-grown specimens the dorsal valve is very gibbous, with a defined mesial fold reaching above the middle of the shell, sharply truncate in front, and usually bearing six or seven plicaations; the sides of the shell curve very abruptly and almost vertically to the opposite valve. The apex is very abruptly incurved beneath the beak of the opposite valve.

Surface in young shells marked by about four plications in the mesial sinus; while there are from ten to fifteen on the sides of the shell,

which are often obscurely defined. In old shells there are forty or more rather broad, rounded, moderately elevated plications, of which from six to eight are depressed in the sinus, and a corresponding number elevated on the mesial fold. These, as well as some of the lateral plications, are usually bifurcated above the middle, but occasionally below. Those near the margin, and particularly on the fold and sinus, are flattened and longitudinally grooved. The plications are crossed by fine concentric striæ which are not visibly imbricating.

The casts show a small rostral cavity, bordered by short and rather thin dental lamellæ, with an elongate-ovate muscular impression, and a moderately or scarcely elevated septum in the dorsal valve. The surface shows a beautiful ramified system of vascular markings, the main trunks of which curve around the papillose ovarian spaces, and thence bifurcating are distributed according to the divisions of the plications, giving a branch to each one, and these again usually subdivide towards the extremities. The central and subordinate lateral groovings of the exterior of the plications correspond to the vascular markings and their subdivisions.

The smaller specimens measure sometimes less than half an inch in length and breadth; while the full-grown shells measure from seven-eighths to nearly an inch in length, with a width sometimes exceeding an inch, and a depth frequently of three-fourths of an inch.

This beautiful fossil occurs in considerable numbers in several localities of the Tully limestone, and in full-grown individuals is readily distinguished; but the immature phases are not so easily recognized.

This species was identified by Mr. VANUXEM with the *Terebratula cuboides* of SOWERBY; and the same name with doubt was used in the Report of the Fourth District. M. A. D'ORBIGNY has separated the species originally described by SOWERBY from that described under the same name by PHILIPS (loc. cit.), proposing the name *Atrypa subcuboides* for the latter, citing at the same time the American species as identical.

The British species has a different aspect and has more plications on the mesial fold and sinus, which is proportionally more elevated in front; while in the exfoliated shell all the plications are more angular. It becomes necessary, therefore, to propose a distinctive name for the American species. Although having a gene-

ral resemblance to some of the more gibbous forms of the Lower Helderberg group, this species is so distinct as to render its identification easy.

Geological formation and localities. This species occurs in the Tully limestone, at Tully and at Tinker's falls in Onondaga county; at Ovid in Seneca county; at Benton and Penn-Yan in Yates county, New-York.

Rhynchonella (Stenocisma) eximia.

PLATE LV.

Atrypa eximia: Hall, Report on the Fourth Geol. District of New-York. Illustration 66, fig. 4.

Shell ovate: valves subequally convex in young shells; the dorsal valve becoming gibbous in older shells.

Ventral valve moderately convex on the umbo, becoming somewhat gibbous in older shells; at about one-third the length from the beak, becoming depressed in a wide defined sinus, which bears from four to six plications, and usually not abruptly incurved in front: beak incurved and not closely appressed.

Dorsal valve regularly and moderately convex in young shells, more convex, or a little gibbous in the middle, in old shells; mesial fold becoming visible about the middle or above the middle of the shell, and often quite prominent near the front.

Surface marked by about twenty-six, to thirty or more, angular plications, of which from four to six are depressed in the sinus and a corresponding number elevated on the fold. The plications become obsolete on the cardinal slopes, and gradually increase in size to the centre. The shell is usually exfoliated, so that the finer surface markings are not preserved.

The partial casts of the dorsal valve show the presence of a median septum reaching half the length of the shell. The apex of the ventral valve appears to have been perforate in the young shells.

In this species the young have the form and proportions of *R.* (*S.*) *prolifica* of the Hamilton group; but they are more finely plicated, and attain the size of the larger specimens of that species before the sinus becomes much developed.

Geological formation and locality. This species occurs in the Chemung group, at Ithaca; and is mainly confined to a single stratum, in which it is abundant.

Rhynchonella (Stenocisma) stephani.

PLATE LV.

Shell varying from subtriangular-ovate, with length and width about equal, to rotund or subglobose, with width greater than length; more or less deeply sinuate in front.

Ventral valve depressed-convex or but moderately convex above, curving gradually to the lower lateral margins and more abruptly to the cardinal slope, where it is a little concave; becoming depressed in a broad undefined sinus, which begins at about one-third to one-half the length from the apex; curving gradually in young shells, and very abruptly in older ones, to the elevated front of the dorsal valve : beak slightly incurved, except in the older and more gibbous specimens.

Dorsal valve prominently convex and regularly arcuate from beak to base in young and full-grown shells, but becomes extremely gibbous in old shells, with a prominent fold on the anterior half of the valve.

Surface marked by about twenty-eight to thirty-two angular plications, of which four, five or six are depressed in the mesial sinus and a corresponding number elevated on the mesial fold. The sinus and fold are not distinctly limited, but a smaller and less elevated plication bounds the fold and sinus on either side.

The specimens described are casts or exfoliated shells which do not preserve the finer surface markings. The casts show the impression of short dental lamellæ in the ventral valve and a strong mesial septum in the dorsal valve, reaching somewhat more than one-third the length of the shell.

This species bears considerable resemblance in form and proportions to the *R.* (*S.*) *eximia*, but is more angular in its outline and more coarsely plicated.

Geological formation and localities. This species occurs in the Chemung group near Ithaca, associated with *R.* (*S.*) *eximia*; at Philipsburgh in Allegany county, and also in Cortland county, New-York. It is found near Bedford, Pennsylvania, whence I have received some specimens from Dr. R. P. Stevens.

Rhynchonella (Stenocisma) duplicata.

PLATE LV.

Atrypa duplicata : HALL, Report on Fourth Geological District of New-York ; Fossils of the Chemung group, Illustration lxvii, figs. 2 & 2 *a*. 1843.

SHELL depressed-suborbicular or subquadrate; length and width about equal : valves subequally convex.

VENTRAL valve convex on the umbo, with beak strongly incurved; sides moderately convex, sometimes a little flattened at the baso-lateral margins and very abruptly incurved on the cardinal slopes : mesial sinus beginning near the apex and becoming deep and angular below the middle, usually marked by a single plication, and much produced in front.

DORSAL valve convex, most prominent about the middle or below the middle of its length, curving to the sides and produced in nearly a direct line to the front.

SURFACE of the dorsal valve usually with two prominent plications separated by a deep groove, which is continued from the mesial fold, with one or two obtuse plications on either side, sometimes a single one scarcely defined. On the ventral valve there is usually one plication only in the sinus, which is margined by angular folds; and outside of these there is one, and rarely more, indistinct folds or undulations of the surface. Rarely there are two plications in the sinus, one smaller than the other, with three of unequal size on the mesial fold.

In well-preserved specimens, the surface is marked by fine elevated concentric striæ and faint radiating striæ.

Of the interior, little is known beyond the fact that the dorsal valve is furnished with a distinct median septum, showing some peculiarities at the junction of the crura; while the ventral valve shows short blunt dental lamellæ. Should the entire interior characters become fully known, this will probably prove to belong to a distinct genus.

The shell is usually about three-eighths of an inch in length and breadth, rarely attaining the length of half an inch.

It is abundant in certain layers in a few localities; but as far as known, it does not occur east of the Genesee valley.

Geological formation and localities. This species occurs in the Chemung group, at East-Randolph and Connewango in Cattaraugus county; at Cherry creek and at Howard on Chautauque creek, and more abundantly at Dexterville in Chautauque county, New-York.

Rhynchonella (Stenocisma) contracta.

PLATE LV.

Atrypa contracta : Hall, Report on the Fourth Geol. District of New-York. Illustration lxvi, fig. 3 *a*. 1843.
Not *Rhynchonella contracta* of D'Orbigny.
Atrypa laticosta and var. as above : Illustration lxvi, figs. 1 & 2.
Not *A. laticosta* of Phillips, loc. cit.

Shell transversely oval or subquadrate; length and width about as seven to ten, or nine to twelve, abruptly and deeply sinuate.

Ventral valve prominent upon the umbo, with beak abruptly incurved and closely appressed against the umbo of the opposite valve, gently declining to the lateral and baso-lateral margins, and often nearly flat in the last named portions; the centre abruptly depressed into a broad deep sinus, with sloping sides which are free from plications; extremely produced in front, with a broad linguiform extension which fills a corresponding depression in front of the dorsal valve.

Dorsal valve somewhat gibbous in the middle, regularly convex transversely; the mesial fold becoming prominent a little above the middle, and continuing almost horizontally, or slightly ascending, to the front; the sides curving more or less abruptly to the ventral valve, according to the convexity of the shell.

Surface marked by about sixteen angular plications, varying from sixteen to twenty; of which three are usually depressed in the mesial sinus, with a corresponding number on the mesial fold. The four plications of the fold originate as two at the apex, each becoming divided, the two central ones being usually stronger than the two lateral ones.

The shell when preserved shows fine concentric striæ, and towards the margin a few crowded imbricating folds : the latter are frequently preserved in casts of the interior. In many casts there are no more than fifteen or sixteen plications visible, those towards the margins being obsolete.

In young and half-grown specimens, found associated with the others, there are sometimes but two plications in the sinus and three on the mesial fold (rarely a single one in the sinus); while sometimes there are four plications in the sinus, when the shell is only of medium size.

The casts show a distinct mesial septum reaching nearly half the length of the dorsal valve, and in the ventral valve a short rostral cavity with short dental lamellæ.

This species, though usually preserving its distinctive characters, presents considerable variety of aspect in its different conditions, and in different sediments. The plications are usually subangular or obtusely angular; but in some specimens they are quite rounded above, while in others they are abruptly angular, and the entire shell has a less expanded form. It often happens, in those forms with more angular plications, that there are no more than five or six on each side of the mesial fold and sinus; and even the broader forms sometimes present this character. The plications on the lateral portions of the shell are sometimes grooved.

This species assumes not only the varieties of aspect represented in the illustrations on Plate LV, but many others not shown in the figures. The forms illustrated in the Report of the Fourth District, and referred to as varieties of *Atrypa laticosta* of PHILLIPS, are apparently all of this species, and not identical with the European form.

The figures of PHILLIPS (loc. cit.), Plate XXXIV, 153 *c*, *d*, bear a more near resemblance to some of the forms of our species; but the figures of *R. laticosta*, PHILLIPS, as given by Mr. DAVIDSON,* do not correspond with our species; while the illustrations of *R. pleurodon* by the latter author, on Plate XIII, figures 11, 12 and 13, resemble the prevailing form of our species : figures 12 and 13 representing those found in the poorer greenish micaceous shales of the Chemung group. The identifications with *R. laticosta*, as illustrated by Mr. DAVIDSON, therefore cannot stand; that species being more nearly like our *R. orbicularis*, which in turn presents many of the characters of the larger and more robust forms of *R. contracta*. It also becomes extremely difficult to point out differences between this species in its various phases, and some of those forms which occur abundantly in the Waverly sandstones of Ohio, and I am at present compelled to regard them as identical.

* Monograph of British Devonian Brachiopoda, Plate xiv, figures 1–3.

Geological formations and localities. This species occurs in the Chemung group, both in the shales and shaly sandstones of the central part of the group, and also in ferruginous sandstones and conglomerates of the upper portions, and in numerous localities from Tioga county to the western limits of the State. It is found near Owego, near Cortlandville, at Ithaca, on Cayuta creek, at Chemung narrows, Elmira, Painted-post, Bath, Angelica, Rockville, Philipsburgh; near Olean, near New-Albion; near Westfield, French creek, Howard's on Chautauqua creek, Twenty-mile creek and elsewhere; also at Meadville, Pennsylvania, from all of which places I have specimens before me. I have likewise received specimens from Dr. R. P. Stevens, collected at Bradford, Pennsylvania. Specimens from Licking county, Ohio, have the same aspect, and present all the modifications of form, varying number of plications on fold and sinus, and other characters marking the New-York specimens.

Rhynchonella (Stenocisma) orbicularis.

PLATE LV.

Rhynchonella orbicularis : Hall, Thirteenth Report on the State Cabinet, p. 88. 1860.

Shell suborbicular, ventricose on the dorsal valve; width greater than the length.

Ventral valve moderately convex, scarcely gibbous on the umbo; beak incurved; outline gently curving on the lateral and baso-lateral margins, and the centre gently depressed in a broad and strongly defined median sinus.

Dorsal valve gibbous in the middle, arcuate from beak to base; sides abruptly curving to the ventral valve; median fold beginning above the middle of the length, and becoming more prominent towards the front.

Surface marked by about twenty-four or more subangular or rounded ribs, those of the central portion being strong and elevated, and those towards the cardinal slope gradually finer and less distinct. There are four or five plications in the mesial sinus, and from four to six on the mesial fold, which are moderately elevated and gently curving

to the front. The plications on the sides are more or less abruptly curved to the margins of the shell. The shell, when preserved, is marked by fine close concentric striæ : the specimens are usually casts.

I have referred to this species some gibbous forms with moderately elevated mesial folds, in which the plications are subangular or rounded, and the entire shell preserves a rotund form. The original of this species is the largest one that has been observed, and is nearly an inch in length, with a somewhat greater breadth. The more common forms are about three-fourths of an inch in diameter.

This species presents many features in common with *R. sappho* of the Hamilton group; and I am prepared to find, among larger collections, a gradation from one to the other.

Geological formation and localities. This species has been found in the higher beds of the Chemung group; in Chautauque county, New-York; at Meadville, and in some loose masses of the group on Oil creek, Pennsylvania.

Rhynchonella (Stenocisma) sappho, var.

PLATE LV.

Specimens from the ferruginous sandstone of Licking county, Ohio, present all the characteristic features of *R.* (*S.*) *sappho* of the Hamilton group. The specimens vary from about half an inch to three-fourths of an inch in length, with a somewhat greater breadth. The plications vary from obtusely angular to rounded, and often show a distinct groove towards the margin of the shell.

This form is common and even abundant in the ferruginous sandstones known as the upper part of the Waverly sandstone series of Ohio, and it is introduced for comparison with the Hamilton and Chemung forms of New-York.

Genus Leiorhynchus (Hall).

Leiorhynchus : Hall, Thirteenth Report on the State Cabinet, p. 75. 1860.

The shells of this genus are ovate, circular or transverse, with valves unequally convex, and marked by a median sinus and fold in the ventral and dorsal valves respectively.

The surface is plicated by rounded bifurcating plications which are always more conspicuous on the mesial fold and sinus, while they often become obsolete on the lateral portions of the shell; concentrically marked by strong lines of growth. Substance of the shell fibrous, usually thin.

Valves articulating by teeth and sockets; the apex of the ventral valve perforate at some period of its growth, the lower side being completed by deltidial plates. On the interior of the ventral valve, two short diverging dental lamellæ extend into and are joined to the sides or bottom of the rostral cavity; the muscular impression occupies a narrow triangular or ovate-triangular space below the dental lamellæ.

The dorsal valve has a well defined septum, often reaching below the middle of the valve, and divided above, leaving a triangular or spoon-shaped depression. The hinge-plates are narrow strong processes, with sockets embracing the teeth of the opposite valve.

Numerous examples, showing the interior to some extent, have not developed any spiral appendages in the shells of this genus, and I am now quite satisfied that they belong to the Rhynchonellidæ. Externally these shells differ from Stenocisma in the low rounded and bifurcating plications, and their obsolescence on the lateral margins, while they are never interlocked at the junction of the valves. When occurring in the same beds, the two have a different aspect; and Leiorhynchus is abundant in the black shales where Stenocisma rarely occurs. It appears, therefore, desirable to continue these forms under a distinct genus.

These shells are at present known only in the Hamilton and Chemung groups; beginning their existence in the Marcellus shale, being quite abundant in some dark shaly beds in the middle of the group and in the

Genesee slate, and occurring generally in the more shaly portions of the Chemung group.

Leiorhynchus limitaris.

PLATE LVI.

Orthis limitaris : VANUXEM, Geol. Report Third District New-York, p. 146, f. 3. 1842.
Atrypa limitaris : HALL, Geol. Report Fourth District New-York, p. 182, f. 11. 1843.
Leiorhynchus limitaris : HALL, Thirteenth Report on the State Cabinet, p. 85. 1860.

SHELL ovate, suborbicular or transverse, moderately or extremely gibbous, with the sinus and mesial fold more or less developed.

VENTRAL valve in young shells scarcely less convex than the opposite, becoming gradually more dissimilar with the growth. In old shells the ventral valve is rather gibbous near the beak, and gradually depressed below, becoming deeply sinuate, produced in front and abruptly truncate; beak closely incurved.

DORSAL valve more convex than the opposite, gibbous in older shells, the mesial fold becoming developed below the middle of its length; umbo gibbous, and often rising nearly as high as the beak of the ventral valve.

SURFACE marked by numerous angular or subangular plications, those of the mesial fold and sinus distinctly bifurcating, while sometimes a few of those on the sides are divided; concentrically marked by fine striæ as in all the species of this genus.

In the youngest specimens observed, the ventral valve below the umbo is flat or concave; while in those a little older, the two valves are nearly equal, and the shell is nearly circular. The illustrations on Plate LVI present the principal varieties of form of this species.

Geological formation and localities. This species is abundant in the Goniatite limestone of the Marcellus shale; and in the absence of this limestone, it is abundant in certain layers of the Marcellus shale, always characterizing that horizon, a fact which induced Mr. VANUXEM to give it the name *limitaris*. It is widely distributed, occurring in the Goniatite limestone in Schoharie, and in the same position at intermediate points as far as Marcellus in Onondaga county. It is abundant in the shale at Avon, at Leroy, near Alden, and at numerous other places within the State of New-York. I have not seen specimens from any western locality.

Leiorhynchus mysia.

PLATE LVI.

SHELL small, suborbicular; valves subequally convex, with a few strong plications reaching half way from the margin to the beak of the shell.

This species is distinguished by its small size, circular form, and proportionally much stronger plications, of which there are at least three on each side of the fold and sinus, terminating near the middle of the shell. In a few larger individuals, the plications have a greater extent. A single plication marks the sinus. The length of the shell is usually less than three-eighths of an inch; width a little greater. One individual measures nearly a quarter of an inch in length.

In a specimen of *L. limitaris* of the same size, the plications are scarcely perceptible.

Geological formation and locality. This species occurs in the Goniatite limestone of the Marcellus shale, in Schoharie, associated with *L. limitaris.*

Leiorhynchus quadricostata.

PLATE LVI.

Orthis quadricostata : VANUXEM, Geol. Rep. Third Dist. New-York, p. 186. 1842.
" " HALL, Geol. Rep. Fourth Dist. New-York, p. 223, f. 2. 1843.
Leiorhynchus quadricostata : HALL, Thirteenth Report on the State Cabinet, p. 86. 1860.
Compare *Leiorhynchus multicosta* : ID. Ib., p. 85. 1860.

SHELL broadly ovate, somewhat gibbous, with distinct mesial fold and sinus.

VENTRAL valve a little gibbous towards the beak; sides nearly flat, with a wide mesial sinus.

DORSAL valve more gibbous than the opposite, greatest convexity in the middle of the valve; mesial fold prominent.

SURFACE of mesial fold and sinus marked by three, four or five rounded plications, which bifurcate above. Sides of the valves obscurely marked by rounded plications, which become obsolete towards the margin, and sometimes this part of the shell is almost entirely free from any markings whatever.

The specimens originally referred to this species occur in the Genesee slate, and are more or less compressed or otherwise crushed, so that the real form and proportions cannot well be determined. The shell in this rock has been extremely thin, and the incipient plications outside of the mesial fold and sinus are usually almost obliterated by the pressure which has flattened the shell. In the comparison of a considerable number of specimens from the black shale with those of the bluish shales of the Hamilton group below, I am somewhat doubtful as to the propriety of separating the *L. multicosta* from this species, since in that one there is a great variation in the strength of the lateral plications, as well as in the space towards the cardino-lateral margins where they are more or less obsolescent.

The cast of the interior shows an elongate narrowly ovate muscular area in the ventral valve, and a strong septum in the dorsal valve, which is divided above and margined on each side by the muscular imprint. The entire interior of the shell or cast, when preserved, is beautifully marked by the ramifying vascular impressions which enclose the papillose ovarian spaces.

The illustrations show the characteristic features of the species, as occurring in the Genesee slate. The ordinary size of specimens is from three-fourths to one inch in length, with a width nearly the same or a little greater. One specimen measures more than an inch and a quarter in length and an inch and a half in width.

Geological formation and localities. This shell occurs in the Genesee slate at Bigstream point and other places on Seneca lake; near Ogden's ferry on Cayuga lake, and at other places thence to Ludlowville; below Ithaca and elsewhere in the region of Seneca and Cayuga lakes.

Leiorhynchus multicosta.

PLATE LVI.

Leiorhynchus multicosta : Hall, Thirteenth Report on the State Cabinet, p 85. 1860.
Rhynchonella ? laura : Billings, Canadian Journal, No. xxvii, p. 273. 1860.
Compare *Leiorhynchus quadricostata* (loc. cit.), ut sup.

Shell ovate, with the length and greatest width nearly equal (in compressed specimens the width is often greater than the length); sides gently curving from the beak for about two-thirds the length, thence curving abruptly to the front, which is truncate in the middle for the width of the sinus.

Ventral valve gibbous on the umbo, curving to the sides, becoming gradually depressed in the centre and forming a sinus which is broad

and gently defined below the middle of the length of the shell. The umbo is prominent, the beak small and neatly incurved over the umbo of the opposite valve.

Dorsal valve much more convex than the ventral, the greatest gibbosity a little above the middle, gently curving to the sides and baso-lateral margins; the centre elevated in a broad mesial fold.

Surface marked by numerous rounded or subangular plications, of which from three to six or seven are depressed in the sinus and a corresponding number elevated on the fold. The plications of the fold and sinus are always bifurcating, those of the sides simple or obscurely bifurcating, and all usually becoming obsolete at one-third to one-fourth the length of the shell from the apex; concentrically marked by raised thread-like striæ, which sometimes become squamose imbricating folds or lines of growth.

The cast of the ventral valve shows a narrow rostral cavity and slender dental plates, with a lanceolate or lance-ovate muscular area. The ovarian spaces are papillose-striate, and outside of these are the ramifying vascular imprints. The cast of the dorsal valve shows a median septum reaching more than half the length of the shell, divided above, leaving a triangular pit. The muscular imprint is narrow, elongate, and marks the surface on each side of the septum more than half-way to the base.

This species presents considerable variety in its surface characters, varying from specimens with few perceptible plications on the sides of the shell, to those with six or seven on each side, and from three to seven in the mesial sinus. In some of the specimens in the Hamilton shales, the plications are numerous, subangular, reaching to the apex of the shell, and showing distinct bifurcations in those of the lateral as well as the mesial portion of the valve.

In order to make a comparison with the Canadian species, I have procured specimens from Bosanquet and Widder in Canada West; and I find the same variations among them as in those of New-York. In seventeen specimens examined, there were two corresponding essentially with the figure of Mr. Billings (loc. cit.), except that the plications are obsolete towards the beak: one of these specimens is about an inch in length and breadth, and the other a little less. In other specimens of nearly the same size, there are four or five plications on the

mesial fold, while those on the sides of the shell are obscure or nearly obsolete; and were they imbedded in an argillaceous shale instead of a calcareous one, they would not be very different in appearance from *Leiorhynchus quadricostata*. Smaller specimens from Widder present almost every phase of development in the plications.

Altogether, accepting for the present the distinction between these forms, I believe they will prove identical; and I am not indisposed to unite with these the *L. mesacostalis* of the Chemung group.

Geological formation and localities. This species occurs in the Hamilton group, from Schoharie county to the western limits of the State. It is common at Fultonham and Summit; at Plainfield and Unadilla forks; and also on the shores of Owasco, Cayuga, Seneca and Canandaigua lakes. It is less common at York, Moscow, Darien and Eighteen-mile creek. The specimens from Canada West are less compressed than those of New-York.

Leiorhynchus iris (n. s.).

PLATE LVI.

Shell small, subangularly ovoid, with a deep sinus and prominent mesial fold.

Ventral valve convex on the umbo, flattened on the sides and deeply depressed in a median sinus below the middle; apex elevated, perforate, the lower side of the foramen bordered by deltidial plates with a distinct narrow area on each side.

Dorsal valve gibbous in the middle, curving abruptly to the sides, and strongly elevated in a mesial fold towards the front.

Surface plicated, the plications subangular, beginning at one-third the length from the apex, some of them obscurely bifurcating; concentrically marked by fine elevated striæ and a few imbricating lines of growth.

Geological formation and locality. In the calcareous shales of the age of the Hamilton or Chemung formations, near Rockford, Indiana. Received from Mr. O. St. John.

Leiorhynchus kelloggi (n. s.).

PLATE LVI.

Shell ovate or suborbicular, more or less rotund, sinuate in the middle; length and breadth nearly equal in the younger shells, the width becoming greater in old shells; the middle of the front abruptly truncate.

Ventral valve gibbous a little below the umbo, curving gently to the sides and becoming gradually flattened in the middle, and deeply sinuate in the lower part. Beak closely incurved over the umbo of the opposite valve, with apex acute.

Dorsal valve regularly convex in the middle and upper part, curving to the sides: the broad flattened mesial fold usually becomes developed below the middle of the length.

Surface marked by low rounded plications, of which there are four, five or six, and sometimes ten in the mesial sinus, and a corresponding number on the mesial fold. There are six or seven plications on each side of the mesial fold; and both these and the central ones usually extend no more than half-way to the apex, and sometimes not so far. When the shell is preserved, there are fine radiating striæ upon the upper half, which are less distinct below; and the entire surface is marked by fine thread-like concentric striæ, which, at intervals, are crowded into stronger wrinkles.

The casts show a narrow ovate muscular area in the ventral valve, with a slender process filling the rostral cavity. In the dorsal valve there is a strong septum, with narrow muscular imprints on each side, reaching below the middle of the length.

A large individual of this species has a length of seven-eighths of an inch with a width of one inch. A smaller specimen has a length and width of three-fourths of an inch.

In some of its phases, this species approaches to the *Leiorhynchus multicosta*; but it is proportionally broader, and the plications do not extend so far towards the beak, while the prevailing aspect is quite different.

Geological formation and locality. Specimens of this species were collected in the northern part of Ohio, from a calcareous rock, associated with *Strophodonta demissa*, *S. perplana*, *Spirifera mucronata*, a species of *Athyris* and a *Meristella*, by Dr. G. M. KELLOGG of Keokuk, Iowa, from whom I have received them.

I have the cast of a single specimen from the Hamilton group in Eastern New-York, which very closely resembles this one, and is probably identical with it.

Leiorhynchus sinuatus (n. s.).

PLATE LVII.

Compare *Leiorhynchus limitaris* (ut sup.).

SHELL ovate or orbicular, more or less distinctly sinuate from the mesial sinus, and truncate in front.

VENTRAL valve moderately convex, with the sides nearly flat, depressed in the middle and extending into a broad shallow sinus.

DORSAL valve moderately convex and sometimes gibbous, gently curving to the sides; the mesial fold broad and flat.

SURFACE marked by about twelve to fourteen or fifteen rather coarse rounded or subangular plications, of which four or five are depressed in the mesial sinus. The sinus and fold are not often conspicuous above the middle of the shell. Concentric striæ as in others of the genus.

It may be found that this form is only a variety of *L. limitaris*, existing under other conditions and at a later epoch. The plications are coarser, and do not extend to the beak as in *L. limitaris*, and the shell attains a somewhat greater size and more robust aspect.

Geological formation and localities. This species occurs in the shales of the Chemung group at Ithaca; at Chemung narrows, and other places in Southern New-York.

Leiorhynchus mesacostalis.

PLATE LVII.

Atrypa mesacostalis : HALL, Geol. Report Fourth Dist. New-York. Illustrations of Fossils of the Chemung group, 64, f. 1 *a* and 1 *b*. 1843.

Leiorhynchus mesacostalis : ID., Thirteenth Report on the State Cabinet, p. 86. 1860.

SHELL oval or ovate, more or less gibbous, sinuate towards the front.

VENTRAL valve usually moderately convex, gibbous on the umbo, gently curving or flattened on the sides, depressed in the middle into a wide shallow sinus; apex closely incurved.

DORSAL valve convex, more or less gibbous, with the mesial fold prominent below the middle of the shell.

SURFACE of mesial fold and sinus marked by four, five or six well-defined rounded plications, which reach nearly or entirely to the apex, and are dichotomous in their upper part. Sides of the shell smooth, or obscurely marked by low obsolete folds; concentrically marked by fine striæ.

In the larger number of specimens, the lateral portions of the fossil are essentially free from plications, but they are sometimes visible, and in a single small specimen there are two plications on either side of the sinus; and one larger specimen shows a similar character. In others, there are inequalities of surface, indicating the plications. It should be recollected, however, that the specimens are usually in the condition of partial or entire casts, and these features may have been more strongly developed in the shell.

The cast of the dorsal valve presents the usual features of all the species in the longitudinal septum, which is distinctly divided on its upper inner face.

It is not difficult to conceive how, by a gradual obsolescence of the lateral plications of the *L. quadricostata* of the Genesee slate, and by acquiring a more robust habit in a different sediment, this form in the Chemung group may be only a modification of that which holds a position in strata several hundred feet below. Although retaining the specific designation for the prevailing Chemung form, I am quite prepared to see the propriety of uniting it with the species just named, and perhaps even with the *L. multicosta* of the Hamilton group.

Geological formation and localities.—This species occurs in numerous localities of the Chemung group in the central part of the State. It has been collected near Ithaca, at Chemung and Chemung narrows, near Elmira, Bath, etc. I have not seen the species in the western counties of Cattaraugus and Chautauque.

Leiorhynchus globuliformis.

PLATE LVII.

Atrypa globuliformis : Vanuxem, Geol. Report Third Dist. New-York, p. 182, f. 2. 1842.

I adopt the name applied by Mr. Vanuxem to some gibbous forms of what appear to be Leiorhynchus. The species is spoken of as occurring "in myriads" in this group of strata in the Third District. I have nevertheless had an opportunity of examining but a few individuals, which are casts of gibbous dorsal valves, marked along the centre by four or five strong rounded plications, which are a little elevated above the general surface of the shell, and margined by a narrow elongate muscular impression. It is possible that larger collections may show the propriety of uniting these with *L. mesacostalis*.

Geological formation and localities. This species occurs in the Chemung group in the south part of Otsego county, and elsewhere in the southeastern part of the State of New-York.

Leiorhynchus dubius (n. s.).

PLATE LVII.

Shell broadly ovate, rapidly expanding in width from about the middle of its length, and wider than long; concave along the cardino-lateral margins.

Valves moderately and almost equally convex; the ventral valve scarcely sinuate, and the dorsal valve with a slightly elevated fold near the front.

Surface marked by twenty-four to twenty-six slender rounded plications, of which about six are raised on the mesial fold. Length half an inch, with the width a little greater.

Of two well-marked specimens, one has a slight fold and sinus, affecting only the front of the shell; the other specimen is not perceptibly marked by this feature. The plications or striæ are finer than in any other species, and extend quite to the apex of the valves.

This species is apparently from the calcareous beds of the Marcellus shale, but the particular locality is not known.

Genus Leptocœlia (Hall).

This name was proposed in the Tenth Report on the State Cabinet (1856, published 1857), for some forms usually referred to Terebratula and Rhynchonella by authors. The genus was described and illustrated in the Twelfth Report on the State Cabinet, 1859.*

I have subsequently found it necessary to separate some of the species originally included under this genus, on account of a different internal structure; but the typical forms remain as first characterized. Unfortunately the specimens have not yet yielded a full knowledge of their interior structure.

Leptocœlia acutiplicata.

PLATE LVII.

Atrypa acutiplicata : Conrad, Annual Report on the Palæontology of New-York, p. 54. 1841.

This species is described by Mr. Conrad as follows : "Short, ovate "acute, compressed, with six to eight acute profound plicæ; beak of "larger valve acute, concave beneath the apex in front; three or four "strongly marked concentric impressed lines. *Locality :* Near Water-"ville, in Onondaga limestone."

The shell is plano-convex, varying in form from ovate acute to orbicular. The ventral valve is moderately convex, with the beak slightly incurved. The dorsal valve is depressed-convex, sometimes flat or concave from compression.

In the greater number of specimens, the plications are from six to eight on each valve, strongly angular; the central one on the ventral valve depressed, and margined on each side by a larger one, while on the dorsal valve two plications are slightly elevated, giving an abrupt sinuosity in front. The shell is concentrically marked by strong imbricating lines of growth.

* See Twelfth Report on the State Cabinet, p. 32; and Palæontology of New-York, Vol. iii, pp. 245 and 447.

Under other conditions, the plications are more numerous and rounded, the squamose imbricating lines less conspicuous, and the shell takes a more orbicular form, approaching to the *L. flabellites;* but the beak is never so strongly incurved as in that species. It may be doubtful whether an examination of a large number of specimens will sustain a separation from *L.* (*A.*) *flabellites;* but while a considerable number of individuals from two or three localities sustain the characters originally given, I shall retain it under a distinct specific name.

Geological formation and localities. This species occurs in the Upper Helderberg limestone, near Waterville and at Cassville, Oneida county; at "Dry-lots," Herkimer county; at Jamesville, Onondaga county, and at East-Victor, Ontario county. Specimens from the same horizon at Waterloo in Seneca county have a more orbicular form, with more numerous and less angular plications.

With our present knowledge of the characters of the Genus LEPTOCŒLIA, the *L. flabellites*, *L. fimbriata* and *L. acutiplicata* will remain as typical forms of the genus, while *Leptocœlia concava*, and *L. dichotoma* (Pal. New-York, Vol. iii, pp. 245 and 452) must be referred to the Genus CŒLOSPIRA; to which may be added the *L.* (*Atrypa*) *disparilis* of the Niagara group.

The species *Leptocœlia* (*Atrypa*) *hemispherica* (Pal. New-York, Vol. II, pa. 74, pl. xxiii, f. 10) and *L.* (*A.*) *planoconvexa* (Ibid. pa. 75, pl. xxiii, f. 11; and Vol. III, pl. ciii B, f. 4 and 5) are apparently true LEPTOCŒLIA, both from external form and from what we know of their internal structure. I nevertheless regard it as desirable to make critical examinations of the Clinton group species, in the hope of arriving at a more satisfactory knowledge of their internal structure and relations.

Genus Camarophoria (King, 1844).

The Genus Camarophoria is described as having the shells of subtrigonal form, with convex valves longitudinally "divided by a sinus and "mesial fold. Beak entire, acute, more or less incurved; under the "extremity of which a small fissure is sometimes exposed : no area or "deltidium. Surface generally plaited, with or without marginal expan-"sions : shell structure impunctate; valves articulating by means of "teeth and sockets.

"In the *perforated valve*, the dental plates are conjoined at their dorsal "margins, forming a trough-shaped process affixed to a low medio-longi-"tudinal plate. In the *smaller valve*, the space between the sockets is "occupied by a small cardinal muscular protuberance or boss; on either "side of which two long slender processes curve upwards, to which "were, no doubt, attached the free cirrated spiral fleshy arms. From "beneath the cardinal process, a high vertical mesial septum extends to "a little more than a third of the length of the valve, supporting along "and close to its upper edge a spatula-shaped process, considerably "dilated towards its free extremity, and projecting with a slight upward "curve to nearly the centre of the shell."

The typical form, *C. schlotheimi* (Von Buch sp.), has the same form and expression of a strongly plicated Rhynchonella, and differs mainly in the trough-shaped process formed by the union of the dental lamellæ. Authentic examples are known in Europe from the Carboniferous and Permian systems, and Mr. Davidson expresses a belief that it will be found in the Devonian. Unfortunately I have had no opportunity of seeing more than a single American species which could be satisfactorily referred to this genus, and that one has a plicated surface and rhynchonelloid form. It is with much hesitation, therefore, that I refer the following smooth shell of Devonian age to this genus.

In making a final examination of the obscure and doubtful material of the Corniferous limestone, containing Meristella, Terebratula,

CRYPTONELLA, etc., I have found a shell of the form of the first named genus, in which the dental lamellæ of the ventral valve are united on the back, forming a trough-shaped process, which is supported on a thin septum extending for half the length of the valve. In the dorsal valve there is likewise a simple median septum extending about one-third the length of the shell, and which, on its upper margin, is expanded, forming a shallow depression. No evidence of oral lamellæ have been observed, but in all essential particulars this internal structure is that of CAMAROPHORIA; and I shall thus refer the species, for the present at least.

Camarophoria eucharis (n. s.).

PLATE LVII.

SHELL broadly ovate, length a little greater than the width.

VENTRAL valve ovate, with the beak extended and arcuate, gibbous above the middle, curving gently to the sides, broadly flattened or a little depressed towards the front, and terminating upwards in a broad short linguiform extension, giving the anterior margin an abruptly rounded or truncate aspect.

DORSAL valve gibbous in the upper part, more abruptly elevated along the middle and towards the front, slightly concave on each side of the broad undefined elevation : anterior margin sinuate. Beak closely incurved into the cavity beneath the apex of the ventral valve.

SURFACE marked by fine concentric striæ, which at intervals are crowded into lamelliform ridges. Shell apparently impunctate.

The interior of the ventral valve has a narrow trough-shaped process, extending about one-third the length of the shell, and supported on a thin median septum which extends beyond the anterior end of the trough. In the dorsal valve, the septum rises vertically for nearly a third of the depth of the cavity embraced by the two valves, and has its upper margin abruptly and narrowly expanded.

The width, in two specimens, is three-fourths of an inch, and the length a little greater.

Geological formation and locality. This fossil was collected in the Corniferous limestone of Canada West, by Mr. J. DE CEW.

OBSERVATIONS ON THE GENERA PENTAMERUS, PENTAMERELLA, STRICKLANDINIA, ANASTROPHIA, AMPHIGENIA, RENSSELÆRIA, etc.

The Genus Pentamerus was proposed by Mr. Sowerby in 1813, to indicate the peculiar internal structure of *P. knightii*, which is the type of the genus. Dalman,* objecting to Sowerby's name, on the ground that the shell was not five-chambered, proposed the name Gypidia as a substitute; but the latter has not been adopted by naturalists.

Since that time, much information has been obtained regarding the disposition of the internal parts of the shells of this genus, through the labors of the European palæontologists de Verneuil, King, Barrande, M'Coy, Suess, Davidson, Salter and others. In the meantime, however, other species have been referred to the genus, which, having the general external characteristics of Pentamerus, still possess features that render their union with that genus incompatible; and farther study has shown the necessity of separating them. Among the European forms which are regarded as strictly referable to the genus, are *P. knightii* (Sow.), *P. vogulicus* (deVer.), *P. galeatus* (Dalm.), *P. sieberi* (Von Buch), *P. pelagicus* (Bar.), and *P. optatus* (Bar.); while *P. oblongus* and *P. lens* have the characteristic features of the genus less conspicuous, the exterior being smooth and the form less rotund. *Pentamerus liratus* and *P. microcamerus* have a straight hinge-line and distinct area.

In 1859, Mr. Billings proposed the separation of certain forms from the typical Pentamerus, under the name of Stricklandia (Stricklandinia†), which he describes as follows :

GENUS STRICKLANDIA = STRICKLANDINIA (Billings).

"Generic characters. Shell usually large, elongate oval, transversely oval or "circular, sometimes compressed : valves nearly equal ; a short mesial septum "in the interior of the ventral valve supporting a small triangular chamber

* Petrefacta Suecana, in Konigl. Vet. Acad. Handl., 1827.

† In consequence of the name being preoccupied in botany, Mr. Billings has proposed to change to Stricklandinia.

"beneath the beak as in PENTAMERUS. In the dorsal valve, no longitudinal sep-
"tum, spires or loop; the whole of the internal solid organs consisting of two
"very short or rudimentary dental plates, which, in some species, bear pro-
"longed calcified processes for the support of the cirrated arms. In all the
"species, the ventral valve has an area more or less developed.

* * * * * * * * * *

"This genus includes three English species, which have been long known under
"the names of *Pentamerus lens*, *P. liratus* and *P. lævis*. All these, and the
"three Canadian species, abound in rocks of the age of the Middle Silurian,
"such as the Llandovery rocks of Sir R. MURCHISON, and the Clinton and
"Niagara groups of the New-York geologists. No species have as yet been
"found either above or below the Middle Silurian. On the other hand, the
"Genus PENTAMERUS occurs more or less frequently in all formations from the
"Black-river limestone to the Devonian inclusive."

The European *Pentamerus liratus* undoubtedly belongs to a genus distinct from *P. knightii*, having a straight hinge-line, an area on the ventral valve, with a sensible mesial depression and corresponding elevation on the opposite valve. The species has likewise a short septum, and supports a small triangular pit in the ventral valve; while in the dorsal valve the hinge-plate is divided, and the parts are extended in long lamellæ into the interior of the valve. The *Pentamerus microcamerus*, M'COY (= *Spirifera? lævis*, SOWERBY), belongs also to the same group, having a straight hinge and narrow area, with a short ∨-shaped pit; characters unlike those of true PENTAMERUS. At the same time, the *Pentamerus lens* and *P. lævis*, which are, by Mr. BILLINGS, united with *P. liratus* under the Genus STRICKLANDINIA, appear to me to differ very widely from that species. They have no area, in the proper acceptation of that term, and the hinge-line is not extended. In the ventral valve, the long ∨-shaped pit is supported on a septum which sometimes extends for nearly half the length of the valve. Moreover, the dorsal valve in the American species of *P. oblongus* is marked by the presence of very extended lamellæ, which are united at their origin and spread laterally till their free margins meet the corresponding margins of the lamellæ forming the ∨-shaped pit in the ventral valve; and running parallel with it for nearly its entire length they then become vertical, and are

continued as far as the middle of the length of the valve, where their extremities apparently become free. In these features, there is no essential difference between *P. oblongus* and *P. knightii* or *P. galeatus*.

In *Pentamerus lens*, or a closely allied form, from Anticosti, the dorsal valve possesses similar characters, and there is no area on the ventral valve. Restricting the designation to such forms as *P. liratus* and *P. microcamerus* among the European species, there is good ground for the separation ; but the other species do not appear to me congeneric. Through the kindness of Sir W. E. Logan, I have been permitted to examine the American species of Stricklandinia, *S. gaspensis*, *S. canadensis* and *S. anticostensis* (Billings), and also the species referred to the European *P. lens*. The first two appear to me to be congeneric with *P. liratus*, and do possess the characters of the genus as described. Limiting, therefore, the application of the term as here indicated, I think we have a well-marked genus, which, typified by the species above named, may also include others heretofore referred with doubt to Spirifera. I conceive, however, that our appreciation of generic limitations will not be enhanced by including under the same term the *P. lens* and *P. oblongus* = *P. lævis*.

Though at first restricting the genus to the Middle Silurian formations, Mr. Billings has, at a later period, included under Stricklandinia the *Pentamerus elongatus* of Vanuxem = *Rensselæria elongata* (Hall), a Devonian species. This form was first placed under Pentamerus, from its resemblance to *P. oblongus* ; and I finally referred it to Rensselæria, from the generally similar shape, similar muscular impressions of the dorsal valve, and the prismatic or punctate texture of the shell ; having at that time an imperfect knowledge of the interior structure of the ventral valve. Now this species has no area on the ventral valve ; but it has a ∨-shaped pit supported by a septum precisely as in Pentamerus ; while both the muscular impression of the dorsal valve, and the structure of the hinge-plate, are precisely the same as in Rensselæria. I cannot see, therefore, upon what good ground this shell should be associated with *P. liratus*, *P. gaspensis*, *P. canadensis* and *P. anticostensis*, which have a straight hinge-line, an area on the ventral valve with a septum

supporting a short V-shaped pit, a different muscular imprint and hinge-processes of the dorsal valve, and a fibrous or lamellose structure of shell, and are otherwise externally marked in a very characteristic manner.

I have taken some pains to bring together specimens of *P.* (*R.*) *elongatus*, and we have now the means of knowing its real characters to a very considerable extent. As before observed, the dorsal valve presents all the characteristics of RENSSELÆRIA in its hinge-structure and muscular impressions : there is the same narrow foramen beneath the hinge-plate, a pedicle-opening, and the filling of this is preserved in several specimens of the casts ; while this portion of the separated valve shows the same features in a most unequivocal manner, and it is quite impossible to point out any characters by which it may be separated from the same part of the shell in RENSSELÆRIA. The crura are free from near their origin, and have been traced for some distance within the cavity, and gently curving to the ventral side ; but their termination is unknown. When, however, we examine the hinge of the ventral valve, we find a modification of the dental plates, which are prominent in RENSSELÆRIA (as shown in fig. 3 *g*, *h* & *m*, Plate CVIII, Palæontology, Vol. iii), but which are here produced anteriorly and united at their dorsal margins. The incipient septum of the bottom of the valve of RENSSELÆRIA becomes developed, and sustains the united bases of the dental plates ; and we have the V-shaped pit and central septum of PENTAMERUS.

In the separated valves of this species, the margins of the triangular fissure of the ventral valve are as clearly defined, and as free from area, as are the valves of ATHYRIS or MERISTELLA.

Generic significations must have some limit, and we cannot consent to unite three so widely differing and well-marked types as *P. liratus*, *P. gaspensis*, etc. with *P. oblongus* and *P. lens* on the one hand, and *P. elongatus* on the other.

There is also another type usually included under the Genus PENTAMERUS, which may be separated with advantage. This one is represented by *P. reversus* (BILLINGS), *P. verneuili* and *P. interplicatus* (HALL), etc.

In these forms the relation of the valves, as in typical PENTAMERUS, is reversed, and the interior structure presents other important differences. For these I shall propose the name of ANASTROPHIA.

There is still a farther separation required among the pentameroid forms, or an extension of the characters of the genus. The *Pentamerus occidentalis* of the Iowa Geological Report presents externally a depressed dorsal valve, with a median fold on the lower valve; while there is a distinct area bordering the fissure, and this area is vertically striated as in many of the Spirifers. The ventral valve has the trough-like pit, formed by the junction of the lamellæ, greatly extended and extremely incurved, and the dorsal lamellæ or crura are divergent and present some peculiarities.

It is doubtless unsafe to base a distinction of genera upon external characters alone, and even with a partial knowledge of the interior structure, we may be misled; but this group of shells presents itself to us under an aspect that will admit of the following arrangement:

1. *Pentamerus* proper, having rotund or gibbous forms, with the ventral valve prominent in the middle, and the dorsal valve flattened or depressed towards the front; lamellæ of the dorsal valve distinct: *P. knightii*, *P. galeatus*, *P. pseudogaleatus*.
2. Elongate forms with the valves subequally convex, lobed or subsinuate; internal structure essentially as in *P. knightii*, and of which *P. oblongus*, *P. lens?* are typical forms.
3. Forms ovate, more or less rotund, with a sinus on the ventral valve and a mesial fold on the dorsal valve; internal structure of the ventral valve as in *P. knightii*. Dorsal valve with the crura or lamellæ of the hinge-plate conjoined so as to form a separate trough-shaped cavity, which unites with the inner surface of the valve; a narrow area on each side of the fissure, and a flattened space or false area along the cardinal margin of the valve. *P. aratus* and *P. papilionensis* are of this type. Genus PENTAMERELLA.
4. Forms more or less elongate, lobed or with mesial fold and sinus; hinge with an extended area on the ventral valve: internally a short ⋁-shaped pit in the ventral valve, supported by a septum. In the dorsal valve, the crura are free almost or quite from their origin (as in SPIRIFERA), and forming no vertical lamellæ. *P. liratus* and *P. micro-camerus* are European forms of this type = the Genus STRICKLANDINIA of BILLINGS; of which *S. canadensis*, *S. brevis*, *S. gaspensis* and *S. anticostensis* are characteristic forms.
5. Short gibbous or ventricose forms; the ventral valve much the larger, with or without mesial fold, a large fissure, and elongate much incurved trough-shaped pit. Dorsal valve depressed in front: an area on both valves; that of the ventral valve striate as in SPIRIFERA: lamellæ of dorsal valve separate and diverging. Genus GYPIDULA, of which *P. occidentalis*, *P. læviusculus* and *P. obsolescens* are types.
6. Rotund or gibbous forms, with the valves, as in ordinary PENTAMERUS, reversed. The ventral valve is the smaller, gibbous in its upper part, depressed or sinuate below, with the ⋁-shaped pit sessile for nearly its entire length; a small flattened space on each side of the fissure. The dorsal valve is ventricose, larger than the ventral, with promi-

nent umbo. The hinge-plate is extended in gradually converging vertical lamellæ which are joined to the shell throughout their length, while the crura are extended into the cavity in thin free lamellæ. Genus ANASTROPHIA,* of which *Pentamerus verneuilii*, *P. interplicata* and *P. reversus* are types.

7. Forms elongate, not lobed. Ventral valve with connected dental lamellæ, forming a trough supported on a septum. Dorsal valve with free crura : no area. Shell-structure punctate. Genus AMPHIGENIA : Type *Pentamerus elongatus* (VANUXEM) = *A. elongata*.

These modifications of a type, of which, until recently, but two genera have been recognized, are well marked in nature, and they seem to me to demand some farther recognition than that of subordination to the Family RHYNCHONELLIDÆ. I shall therefore propose the Family PENTAMERIDÆ to include the genera above enumerated, as well as the Genus CAMAROPHORIA, and probably TRIPLESIA and some of the species of CAMARELLA,† and perhaps also the Genus GYPIDIA of DALMAN, making *G. conchydium* the type.‡ In this arrangement, it appears to me that we have a well-marked family of BRACHIOPODA which has existed from the earliest palæozoic epoch, and has continued throughout the entire series to its close.

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* I am aware that Mr. SHALER, of the Museum of Comparative Zoology at Cambridge, in a Bulletin of that Institution, has proposed the name BRACHYMERUS for these forms ; but since that name is preoccupied for a genus of COLEOPTERA, it cannot be adopted in this relation; and my own determination of the generic distinction of these forms having been made long since, I shall adopt the name proposed above.

† I cannot recognize the rhynchonelloid typical species of CAMARELLA as congeneric with many of those more recently placed under that genus by its author.

‡ In the revision of the PENTAMERIDÆ, I am by no means sure that the Genus GYPIDIA will not be recognized. I have under consideration at the present time an American species of similar external character, presenting certain modifications of the hinge-plate in the dorsal valve, which will require a distinct designation.

Genus Pentamerus (Sowerby).

Types *P. knightii*, *P. galeatus*, etc.

Genus Pentamerella (nov. gen.).

Type *P. arata.*

Pentamerella arata.

PLATE LVIII.

Atrypa arata : Conrad, Ann. Report on the Palæontology of New-York, page 55. 1841.
" *octocostata* : Id. Ib.
Pentamerus aratus : Hall, Tenth Report on the State Cabinet, p. 120. 1857.

Shell ovate, more or less convex or gibbous, becoming arcuate-ovoid in old shells; the width greater or less than the length : hinge-line variable.

Ventral valve gibbous and somewhat regularly convex in the young shells, becoming ventricose in old shells, with a mesial sinus which is more or less developed. In old shells, the form is extremely arcuate and the beak strongly incurved; in shells of medium size, the beak is obtuse, limiting the apex of the triangular fissure. There is a narrow area bordering the fissure and the space on either side, between the hinge-line and its apex, is often flattened, and sometimes distinctly limited by a faint elevation : fissure large, and nearly covered by the beak of the opposite valve.

Dorsal valve, in young shells, more or less convex, and sometimes gibbous in the upper part, and often only moderately convex in older shells; mesial fold usually well defined in the lower half of the valve, sometimes reaching nearly to the apex : in young shells there is rarely a short sinus in place of the mesial elevation.

Surface plicated by rounded or angular plications, which sometimes reach nearly or quite to the beak, but are often only developed below

the first third of the length : plications usually bifurcated; the bifurcations irregular or unequal.

The interior of the ventral valve has an elongate spoon-shaped pit, the inner extremity of which is free for a considerable extent, and the upper part supported on a central septum which usually extends less than half the length of the shell from the apex.

In the dorsal valve, the crura or lamellæ are conjoined at their bases, making a ⋁-shaped trough or pit, which is attached to the valve in its upper part and continues sessile for about one-half the length of the shell.

This species, in its various phases of growth and development, presents much variety of aspect and form. In some extreme specimens, it approaches to the form of *P. knightii*, but its prevailing proportions and characters are extremely different. In young shells the form is sometimes not unlike that of RHYNCHONELLA; but the greater gibbosity of the ventral valve and the bifurcation of the plications offer ready means of distinction. In some of its forms it approaches in character the *Pentamerella papilionensis* of the Hamilton group; but the surface is usually marked by a greater number of plications, which are usually more or less angular.

I have heretofore (Report on State Cabinet, ut cit.) identified the *Atrypa arata* and *A. octocostata* of CONRAD as different phases of this shell, and farther examination has confirmed this opinion. With a few specimens, each of which might be a typical form, it is not difficult to recognize three tolerably distinct varieties of this species; but with a larger number of specimens, they are all shown to belong to the same type, and do not offer the means of specific distinction.

This species, in the collection before me, ranges from half an inch in length and breadth to specimens having a length of two inches or more, with a width of an inch and a half.

Geological formations and localities. This fossil occurs in the Schoharie grit, and in limestones of the Upper Helderberg group, in Albany and Schoharie counties, New-York. It occurs in the same limestone in Cherry valley, at Waterville and Babcock's hill in Oneida county, at Lima in Ontario county, at Caledonia in Livingston county, and Leroy and Stafford in Genesee county; and at Clarence hollow, and five miles east of Buffalo, in Erie county. It is known in Canada West, and at the Falls of the Ohio.

Pentamerella papilionensis.

PLATE LVIII.

Pentamerus papilionensis : Hall, Geol. Rep. Iowa, Vol. I, part ii, cited p. 514. 1858.
" " Idem, Thirteenth Report on the State Cabinet, p. 86. 1860.

Shell ventricose, broadly ovate, often wider than long, more or less gibbous and arcuate in old shells.

Ventral valve gibbous or ventricose above, becoming depressed in the middle into a broad shallow, often undefined sinus, which scarcely reaches to the beak and sometimes not much above the middle, and is produced in front; sides abruptly curving to the margin : beak incurved, obtuse, arching from the broad fissure; cardinal line extending for more than half the width of the shell. The space above, on each side of the fissure, is concave and wrinkled.

Dorsal valve gibbous in the middle, somewhat regularly curving to the sides and front; mesial fold defined below the middle of the valve.

Surface plicated, the plications rounded or subangular, becoming obsolete towards the beak, and prominent below the middle : of these there are two or three in the mesial sinus, and usually about four on the mesial fold, with three, four or five on either side. The plications are crossed by fine concentric striæ of growth, which at irregular intervals are crowded into squamose imbricating lines. The entire surface is finely papillose or punctate, and when well-preserved might be mistaken for a punctate shell. The substance of the shell is lamellose-prismatic and brittle.

The interior of the ventral valve shows a broad short and deep spoon-shaped pit, the extremity of which is bent abruptly to the dorsal side. The septum supporting the conjoined lamellæ extends from one-third to one-half the length of the valve, and in some examples may extend still farther towards the anterior margin.

The interior of the dorsal valve is not fully known.

This species bears much resemblance to *P. arata*, in some phases of the latter; but the plications are usually less numerous, rounded and simple, and the shell is more regularly ovate, and never so large and extremely arcuate as in that species.

The specimens are for the most part in a crushed and distorted condition; and among a hundred individuals, there is not one preserved in its perfect form.

This species resembles *P. occidentalis* (= *Gypidula occidentalis* of Iowa) in general form; but the plications are more numerous, and extend farther towards the beak, which is more arcuate and less obtuse; and the ventral valve is marked by a mesial elevation instead of a sinus.

Geological formation and localities. This species occurs in the shales of the Hamilton group on the shores of Seneca and Canandaigua lakes, at Geneseo, York and Moscow, Livingston county; at Pavilion in Genesee county, and elsewhere in Western New-York.

Pentamerella micula (n. s.).

PLATE LVIII.

Dorsal valve subcircular or transverse, regularly convex. Surface, towards the beak, smooth or marked only by concentric lines of growth; the lower part of the shell marked by fifteen to twenty short rounded or subangular plications, of which five or six in the middle are slightly more elevated, giving indication of a mesial elevation. Interior of the valve with the lamellæ converging from their origin, and forming a pointed sessile trough, which is contracted where embraced by the teeth of the opposite valve, and expanded near the hinge-line. There is a short low septum just within the apex of the pit, with apparently a narrow area on each side of the fissure.

Two specimens of this form, from rocks of the age of the Hamilton group near Iowa city, were received several years since; and the character of the trough or pit in the dorsal valve induced me to regard them as belonging to a distinct genus, but the insufficiency of the material has caused them to be neglected until the present time. The pit is more shallow and expanded than that of *P. arata*.

Pentamerella obsolescens (n. s.).

PLATE LVIII.

SHELL small, gibbous or ventricose, about as wide as long.

VENTRAL valve ventricose above the middle; umbo prominent: beak abruptly incurved over a large triangular fissure, with the shell flattened along the cardinal margin.

DORSAL valve regularly convex below, gibbous above: beak prominent, scarcely incurved, with an apparent narrow area on each side the fissure.

SURFACE smooth, or with nearly obsolete radiating folds.

Interior of ventral valve with a pit or trough supported on a short septum; and in the dorsal valve there is a short sessile trough made by the converging lamellæ, which reaches to about the middle of the length of the valve.

Geological formation and locality. In shale of Devonian age: Waterloo, Iowa. Received from Mr. O. ST. JOHN.

Pentamerella dubia.

PLATE LVIII.

Spirifer dubius: HALL, Thirteenth Report on the State Cabinet, p. 90. 1860.

SHELL ovoid, ventricose; cardinal extremities rounded; length and width sometimes equal, the length in young shells greater than the width: depth of the two valves equal to two-thirds the width.

VENTRAL valve gibbous or ventricose, extremely arcuate, with a flattening or subsinuation and extension of the front: umbo prominent, and extended beyond that of the opposite valve one-fifth or more of its length; apex strongly incurved.

DORSAL valve gibbous, much shorter than the ventral, prominent in the middle above, with a more or less defined mesial fold towards the anterior margin, which is marked by four or five plications which coalesce and become obsolete before reaching the apex.

SURFACE marked by from fourteen to twenty or more plications which show a tendency to bifurcate near the margin, and in old shells are entirely obsolete on the upper part of the valves: plications crossed by imbricating lamellæ.

Geological formation and locality. This species occurs in rocks of the age of the Hamilton group near Iowa city, Iowa.

Genus Gypidula (n. g.).

[Gr. γυψ, *vultur*; in allusion to the strongly incurved beak.]

Generic characters as given on page 373 of this volume.

Type *G. occidentalis*.

Gypidula occidentalis.

PLATE LVIII.

Pentamerus occidentalis : Hall, Geology of Iowa, Vol. I, part ii, pa. 514, pl. vi, f. 2. 1858.
Not " " Idem, Pal. New-York, Vol. II, p. 341. 1852.

Shell subovoid, gibbous, very inequivalve; hinge-line equalling three-fourths the entire width of the shell.

Ventral valve arcuate, gibbous or ventricose in the upper part; beak extended, strongly incurved, obtuse; fissure large and bordered by a distinct area which is vertically striated. The spoon-shaped pit is deep, extremely extended and incurved. The middle of the valve, below the first third, elevated into a more or less distinct mesial fold which is marked by two or three plications.

Dorsal valve gibbous above, becoming flattened below the middle, sometimes concave at the sides, and the front depressed into a deep and more or less distinctly defined sinus. A narrow area extends for about two-thirds the length of the hinge-line.

Surface plicated below by a few rounded or subangular plications which become obsolete above; the upper part of the valve marked only by concentric striæ.

Geological formation and locality. In strata of the age of the Hamilton group, at Independence, Iowa.

Gypidula læviuscula (n. s.).

PLATE LVIII.

Shell varying from subcircular to broadly ovoid, gibbous in the young state, becoming ventricose.

Ventral valve, in the young shell, regularly convex, with beak abruptly pointed and neatly incurved, becoming more gibbous or ventricose as the shell increases in size, with the umbo prominent and beak arcuate; regularly curving to the sides and front, without mesial sinus or elevation.

Dorsal valve regularly convex in young shells; old shells more gibbous above, and becoming broadly depressed towards the front, without distinct sinus. Area distinct; beak scarcely incurved.

Surface smooth or marked by concentric striæ, which are slightly undulated towards the front of the shell; and in a large specimen, the exfoliated surface is obscurely marked by fine striæ.

The young specimens of this species have much the aspect of Nucleospira; but when the cardinal line is visible, there is a conspicuous triangular fissure with a flattened space on each side. This feature is sometimes quite marked in the separated ventral valve. The spoon-shaped pit is comparatively wide and deep, and supported on a short septum. In the dorsal valve the lamellæ are divergent from their origin.

The largest specimen before me has a length of seven-eighths of an inch, with a slightly greater width.

Geological formation and locality. Collected from strata of Devonian age, at Waterloo, Iowa, by Mr. O. St. John, to whom I am indebted for the specimens.

Genus Amphigenia (nov. gen.).

[Gr. *αμφι, utrinque*; and *γενεα, generatio.*]

Shells inequivalved, oval, ovoid or subtriangular, more or less convex or gibbous, without mesial fold or sinus. Valves articulating by teeth and sockets, without area. The dental lamellæ in the ventral valve conjoined on their dorsal sides, forming an angular trough or pit, which opens exteriorly by a triangular fissure beneath the beak, and in its anterior extension is supported on a central septum. Dorsal valve with a strong thickened cardinal process or hinge-plate, bordered by the teeth sockets, anchylosed to the bottom of the valve and supporting the crura, which extend into the cavity of the shell.*

In all the specimens examined, there is a foramen extending beneath the hinge-plate, and ending in a perforation at the beak. The shell substance is distinctly punctate, and, in exfoliated specimens, presents a prismatic structure. So far as known, the crura terminate in slender extensions, without appendage of any kind; but we have had no specimens in a condition to enable us to ascertain their entire character.

The type of this genus, *T. elongata*, has been placed by Mr. Billings under ihe Genus Stricklandia = Stricklandinia, from which I regard it as differing in having no area on the ventral valve, a more extended angular pit, a very different hinge-plate, with a foramen in the dorsal valve, and a punctate shell-structure.

The shells of this genus were referred by me to the Genus Rensselæria, for reasons already mentioned. They differ from that genus in the angular pit or trough made by the conjoined dental lamellæ of the ventral valve, and (with our

* The following remarks upon the dorsal valve of Rensselæria (Pal. New-York, Vol. iii, pp. 454 and 455) are precisely applicable to the dorsal valve of Amphigenia: "In the dorsal valve, the dental "sockets lie between the shell proper and a strong, often much thickened process, from the anterior "extension of which proceed the slender crural processes." * * * * * "The cardinal process at the base of the crura is often much thickened, and sometimes extends for- "ward into the shell much more than in others; and, when it becomes thickened in old shells, is "often distinctly marked by two grooves upon its summit. Behind this process, and between it and "the beak, there is a distinct round foramen communicating beneath with the interior cavity of the "valve."

present knowledge) in the free crura of the dorsal valve without apparent appendage. The muscular impression in the dorsal valve is precisely alike in the two genera, and the shell is punctate and externally striate in precisely the same manner. RENSSELÆRIA belongs to the Family Terebratulidæ; while PENTAMERUS and STRICKLANDINIA are of the Family Rhynchonellidæ = Pentameridæ, as usually understood. The Genus AMPHIGENIA, in its punctate shell and modification of the hinge in the dorsal valve, offers absolute affinities with RENSSELÆRIA, while in other features it presents characters intermediate between the Pentameridæ and Terebratulidæ.

Amphigenia elongata.

PLATE LIX.

Pentamerus elongatus : VANUXEM, Report Third Geol. Dist. New-York, p 132. 1842.
" " Geol. Report Fourth Dist. New-York, p. 34. 1848.
Meganteris elongatus : HALL, Tenth Report on the State Cabinet, p. 123. 1857.
Rensselæria elongata : ID. Pal. New-York, Vol. iii, p. 453.
" " " Twelfth Report on the State Cabinet, p. 37. 1859.
Stricklandia elongata : BILLINGS, Canadian Journal, No. xxxiii, p. 268. May, 1861.
" " ID. Geology of Canada, p. 371.

SHELL elongate-oval or ovate, subcylindrical, more or less convex or gibbous, variable in form, sometimes nearly as wide as long; the sides curving or nearly straight; front rounded or subtruncate.

VENTRAL valve usually the more convex, often abruptly elevated or obtusely subangular along the middle; umbo prominent : beak abruptly attenuate and closely incurved over the umbo of the opposite valve.

DORSAL valve more or less convex or sometimes gibbous in the upper part, often more prominent or subangularly elevated along the middle of the upper part, and depressed-convex towards the sides and on the lower part, without evidence of mesial fold or sinus.

SURFACE covered by regular radiating flattened striæ, with fine concentric lines which are often crowded into squamose imbricating ridges of growth. When partially exfoliated, the radiating striæ are only obscurely or not at all visible, and the concentric striæ appear to be the external markings of the surface. Entire shell-structure punctate.

This fossil is extremely variable in form; in the young state it is often as wide as long or wider, the hinge-line extended, and the greatest

width a little below the hinge, rapidly narrowing to the front. Other specimens of similar age are broadly ovate or oval, the dorsal valve depressed-convex. As the shell becomes older, the convexity increases; though we meet with specimens of an inch and a half in length and width, where the depth of the two valves is but three-fourths of an inch; and in one specimen of a dorsal valve three inches and a half long, the depth has been but about five-eighths of an inch. In a very symmetrical specimen of the ventral valve about three inches long, the width is half as great, and the depth five-eighths of an inch.

This shell sometimes reaches a length of nearly four inches; though the prevailing size is from two and a half to three inches in length. It is frequently crushed, and well-preserved, entire and symmetrical specimens are very rare.

A specimen from Michigan, received from Dr. C. Rominger, and one collected at Mackinac from the same geological horizon, are strongly wrinkled concentrically, but marked with similar radiating striæ which are obscurely preserved.

The species described under the name *Meganteris subtrigonalis* (Tenth Report on the State Cabinet, page 123, 1857) appears to be only a variety of this species, and, if found of sufficient constancy, might be thus indicated.

Geological formations and localities. This species occurs in the Schoharie grit, where it is recognized by casts of the interiors of the valves. It is found in the Upper Helderberg limestones at many localities between the Hudson and Niagara rivers, and in Canada West. The principal localities from which I have specimens before me, are Vienna, Ontario county; Caledonia, Livingston county; Clarence hollow and Williamsville, Erie county. It occurs in Albany and Schoharie counties, along the outcrop of the Upper Helderberg limestone, and at Cherry-valley, Otsego county, and Bridgewater, Oneida county, New-York.

Amphigenia elongata, var. undulata.

PLATE LIX.

Shell smaller than the preceding; ventral valve very gibbous, and marked by strong concentric undulations, and obscurely by fine radiating striæ.

The specimens are apparently old shells and have a length of only about an inch.

It is desirable to compare a larger number of individuals, before this form can be entitled to specific distinction.

Geological formation and localities. In the Upper Helderberg limestone, at Mackinac, and from Michigan: the latter received from Dr. C. Rœminger.

Genus Rensselæria* (Hall).

The following species possesses many of the important characteristics of the Genus Rensselæria, in the elongate-oval or subcylindrical form. The punctate shell and the muscular impression of the dorsal valve correspond with shells of that genus.

Rensselæria? johanni (n. s.).

PLATE LX.

Shell oval or subovate, and, in full-grown individuals, elongate oval in outline, or subcylindrical : valves subequally convex.

Ventral valve, in young specimens, more gibbous in the upper part, and sloping to the front. In older shells the valve is regularly convex, sometimes prominent or subangular along the middle; the beak closely incurved over that of the opposite valve.

Dorsal valve regularly convex; in old shells, acquiring nearly the same convexity as the ventral valve : in some specimens, much less convex, and extended on the hinge-line.

Surface marked by concentric striæ of growth, which are at intervals crowded into stronger ridges or imbricating folds. Shell-structure punctate.

The cast of the dorsal valve shows muscular imprints similar to those of Rensselæria; while in the cast of the ventral valve, the filling of the rostral cavity is less prominent.

In some young specimens, which appear to be of this species, the valves are only moderately convex, and there is an indication of area upon the dorsal valve.

The materials in my possession are in such a condition as to prevent a satisfactory examination of all the parts, and a positive reference of the species can only be made from an examination of the internal structure. The form of the shell, incurvation of the ventral valve, and general aspect are very similar to Rensselæria; but the characteristic radiating striæ have not been observed upon the surface.

Should its interior structure prove it generically distinct from that genus, I would propose the name Rensselandia.

Geological formation and locality. In limestone of the age of the Upper Helderberg, Waterloo, Iowa; from Mr. O. St. John.

* Rensselæria, Hall : proposed and printed in Vol. iii, Palæontology of New-York, 1858; published in Twelfth Report on the State Cabinet, p. 39. 1859.

Genus Terebratula (Lhwyd, 1696).

Among the fossils of the Upper Helderberg and Hamilton groups, several species present externally and internally the features of Terebratula. The shell-structure is punctate, the beak incurved and terminated by a round perforation, which is limited on the lower side by two deltidial pieces. In other species of punctate structure, there is a certain modification of muscular marking which has induced me to separate them from Terebratula, under the name Cryptonella. With our present knowledge of external forms and characters, it is not possible to distinguish generically those with a short terebratuloid loop from such forms as *Centronella julia*, without knowing their internal structure; while certain other forms, with flat or concave dorsal valve and punctate structure, we regard as congeneric with *C. glans-fagea*. Unfortunately, our specimens from the Hamilton group, though numerous, are rarely in a condition to show the loop or internal structure, and we are usually forced to rely upon external form and the muscular impressions of the casts.

In consequence of the finely punctate character and terebratuloid form of these shells, I refer them, with little hesitation, to the Family Terebratulidæ; and while some of them are known to be true Terebratulæ from their internal structure, others are referred to that genus from similarity of external form and character. Among the following species placed under this genus, four of them are known to possess the short terebratuloid loop.

Terebratula lens.

PLATE LX.

Terebratula lens : Hall, Thirteenth Report on the State Cabinet, p. 89. 1860.

Shell ovate, broadly elliptical or lenticular below the beak, which is abruptly tapering; moderately gibbous, the valves subequally convex, the greatest width a little below the middle, the width about four-

fifths as great as the length, and the depth nearly equal to half the length.

Ventral valve a little less convex than the dorsal; the beak moderately incurved and broadly truncated by the foramen : no visible sinus or elevation in the middle of the valve.

Dorsal valve broadly elliptical or subcircular, somewhat regularly convex; the beak closely appressed below that of the opposite valve.

Surface marked by concentric lines of growth; the shell-structure distinctly punctate.

The length of an ordinary specimen is seven-tenths of an inch, the width six-tenths of an inch.

I have continued this species under the Genus Terebratula, without having any satisfactory evidence of its internal structure ; though it may hereafter prove to belong to the Genus or Subgenus Cryptonella. This species is shorter, broader and less gibbous than the *T.* (*Cryptonella*) *lincklæni*, or the *T.* (*C.*) *rectirostra ;* and it is larger and less gibbous than the *T. rœmingeri.*

Geological formation and locality. This species occurs in the Corniferous limestone, at Clarence-hollow, Erie county, New-York.

Terebratula sullivanti (n. s.).

PLATE LX.

Shell elongate-ovate or subspatulate, truncate or emarginate in front, of moderate convexity; width and length about as four to six, or seven to nine.

Ventral valve a little less convex than the opposite; the beak much extended, neatly attenuate and perforate at the apex; the cardinal slopes rounded and a little concave near the hinge margin, usually depressed towards the front, and sometimes a shallow sinus which reaches one-third or one-half the length of the valve.

Dorsal valve a little more convex and considerably shorter than the ventral valve, usually flattened and sometimes depressed along the centre of the lower part of the valve.

Surface marked by fine close concentric striæ which are neatly rounded on well-preserved specimens, and at intervals are crowded into more prominent ridges. Shell-structure punctate.

On cutting down a specimen of this species, it has been found to possess a short simple loop, without appendage, as in Terebratula.

The larger specimens are about three-fourths of an inch in length.

The shell is readily distinguished by its elongate form, moderate convexity, truncate or sinuate front, and median depression in the ventral valve; features which I have not observed in any other species in this geological formation.

Geological formation and localities. This species occurs in the Upper Helderberg limestone, at Columbus and Sandusky, Ohio; and in the neighborhood of Cayuga, Canada West.

Terebratula harmonia (n. s.).

PLATE LX.

Shell ovate or subspatulate, tapering somewhat abruptly to the beak, convex in the middle and compressed at the margins.

Ventral valve regularly arcuate from beak to front, moderately convex in the middle, a little gibbous above and depressed-convex or slightly concave towards the front, the upper part narrowing; the beak much extended, attenuate and arcuate, but not closely incurved; apex perforate, the slope to the cardinal margin scarcely concave: deltidial plates large.

Dorsal valve moderately convex, sometimes a little more prominent along the middle in the upper part, and depressed towards the front and sides.

Surface marked by fine concentric lines of growth; the substance of the shell finely punctate.

A well-marked specimen of this species has been cut down on the dorsal side, revealing the loop, the divisions of which extend for more than one-third the length of the dorsal valve; the angle of return being visible, but not the connecting portion.

Young specimens, which I refer to this species, are more gibbous than the older ones. The larger specimens are from six-eighths to seven-eighths of an inch long and five-eighths of an inch wide.

This species is proportionally wider and with more extended beak than the *T. sullivanti*, and more regularly arcuate from beak to base of the ventral valve : it is, moreover, not emarginate in front. It appears to be a well-marked species, and, in its larger individuals, will be readily distinguished.

Geological formation and localities. From the limestone of the Falls of the Ohio (sent to me by Dr. JAMES KNAPP of Louisville, Kentucky) ; and also from the Corniferous limestone of Canada West : collected by Mr. DE CEW.

Terebratula rœmingeri.

PLATE LX.

Terebratula rœmingeri : HALL, Sixteenth Report on the State Cabinet, p. 48. 1863.

SHELL ovate, more or less gibbous, truncate or slightly sinuate in front.

VENTRAL valve gibbous above the middle ; umbo gibbous, inflated ; beak prominent, incurved over the opposite beak, and truncated by a round foramen which is often mainly anterior to the apex, and completed on the lower side by two deltidial plates : cardinal slopes rounded, often depressed in the middle towards the front.

DORSAL valve extremely gibbous, little longer than wide ; the greatest convexity at the middle or above.

SURFACE marked by fine concentric striæ which are often crowded into prominent wrinkles towards the front. Shell-structure finely punctate.

The interior shows a short terebratuliform loop, which is abruptly recurved at its lower extremities.

This species was first indicated from specimens sent by Dr. RŒMINGER, from Thunder bay, Michigan ; but it has since proved of common occurrence in New York. The Michigan specimens are usually more gibbous and distinctly depressed or sinuate in front ; while that character, though present in some of the eastern specimens, is not constant. There is, however, no difficulty in recognizing the characters of the species in any well-preserved specimens.

This species is the smallest of the genus, or of the family, known as occurring in the Hamilton shales of New-York.

Geological formation and localities. The original or type specimens of the species occur in beds of the age of the Hamilton group, at Thunder bay, Michigan. It is found in the same horizon at York in Livingston county, and at Hamburgh on the shore of Lake Erie. It has likewise been found at Waterloo, Iowa, by Mr. R. P. Whitfield.

Terebratula elia (n. s.).

PLATE LX.

Shell ovate, arcuate on the ventral side; beak prominent.

Ventral valve regularly arcuate from beak to base, gibbous in the middle and above; umbo prominent; beak little incurved and broadly truncate by a rounded foramen, which is limited on the lower side by two large deltidial pieces.

Dorsal valve regularly convex, the greatest convexity in the middle, where it is about equal to that of the opposite valve. The depth, width and length are as two, three and four-eighths of an inch.

Surface concentrically striate, shell-substance punctate.

Geological formation and locality. This species occurs at Waterloo, Iowa, in strata of the age of the Upper Helderberg or Hamilton group. Received from Mr. O. St. John.

Terebratula jucunda (n. s.).

PLATE LX.

Shell subcircular or very broadly ovate, the length and width about equal, regularly rounded below and abruptly narrowing above the middle.

Ventral valve gibbous in the middle, curving regularly to the base and baso-lateral margins; beak obtuse, and incurved over the umbo of the opposite valve; apex truncated by a rounded foramen.

Dorsal valve rather regularly convex, the greatest convexity a little above the middle, curving to the base and baso-lateral margins.

Length of specimens, a little more than three-eighths of an inch.

On cutting down from the dorsal side, the loop is visible, showing the terebratuloid character.

Geological formation and locality. In strata of the age of the Upper Helderberg or Hamilton group, at Waterloo, Iowa. Received from Mr. O. St. John.

Terebratula navicella (n. s.).

PLATE LX.

Shell elliptical, subnaviform, arcuate on the ventral side, slightly linguiform in front.

Ventral valve extremely arcuate, flattened or subsinuate towards the front, depressed convex in the middle, and a little prominent on the umbo : beak extended, recurved and truncated by a rounded foramen almost in the plane of the longitudinal axis; deltidial pieces conspicuous.

Dorsal valve prominent along the middle, nearly straight from the base to the umbo, sloping somewhat abruptly to the sides.

Surface marked by fine concentric striæ which are sometimes crowded into stronger ridges. Structure distinctly punctate.

On cutting down the dorsal side, there are some obscure indications of short crura which are not united below; but this is a common condition, the connecting portion of the loop having often been broken away.

Geological formation and locality. This species occurs at Rockford, Iowa, in beds of the age of the Hamilton or Chemung group of New-York. Received from Mr. O. St. John, and collected at the same place by Mr. R. P. Whitfield.

Terebratula simulator (n. s.).

PLATE LX.

Shell elongate-ovate or spatulate, moderately convex; the beak of the ventral valve much extended, and truncated almost rectangularly to the longitudinal plane.

A specimen received from Dr. Rœminger, collected in the Hamilton group at Widder, Canada West, shows the crura extending for about half the length of the dorsal valve; but the connecting portion of the loop is not preserved.

Genus Cryptonella (Hall, 1861).

Cryptonella : Hall, Fourteenth Report on the State Cabinet, p. 102. 1861.
" Id. Fifteenth " " " pp. 132 & 133. 1862.
" " Sixteenth " " " p. 43. 1863.

Shells equilateral, inequivalve, elongate, oval or ovoid ; valves unequally convex, without median fold or sinus, or with this character moderately developed and principally towards the base of the shell. Ventral valve with beak extended or incurved, perforate; foramen terminal, the lower side formed by two small triangular deltidial pieces, or, in their absence, by the umbo of the opposite valve. Shell-structure finely punctate. Surface smooth, or with concentric striæ. Valves articulating by teeth and sockets, the dental lamellæ of the ventral valve extending downwards into the cavity of the shell. The muscular impressions in the dorsal valve are strongly marked above, and extend in two narrow separated impressions more than halfway to the front of the shell : the ventral cast shows elongated muscular and vascular impressions.

The species of this genus are more elongate than Merista and Meristella, and those now known are less distinctly marked by mesial fold and sinus; while the beak is more attenuate, often a little flattened, and rarely so closely incurved, as in the genera cited. The punctate structure of the shell is a distinguishing character.

This genus was first described as above cited, and figures of the exterior form and of the interior of the valves were given in the Fifteenth Report. The results of some farther investigations were given in the Sixteenth Report, and an illustration of what was supposed to be the internal appendages of the shell. About the same time it was discovered that some punctate shells of the same general form possessed the loop of Terebratula proper ; and it became a matter of great interest, and still greater difficulty, to determine the internal structure of the species. I had referred to this genus the *Terebratula lens*, *T. lincklæni*, *T. rectirostra*

and *T. planirostra*, species described in a preceding report. Having ascertained that the internal loop in *Centronella glans-fagea* is essentially similar to that of *C. julia* (WINCHELL), a species having the external form of CRYPTONELLA, I supposed it possible that the two genera might be merged into one. Since that time, I am not aware that any farther investigations have been made, tending to throw light upon this subject.

It has therefore appeared to me very desirable to learn, if possible, the internal structure of any one of those species which I originally referred to the Genus CRYPTONELLA. Of two of these, *C. rectirostra* and *C. planirostra*, I have fortunately been able to obtain an exposition of the form and structure of the loop, as will be shown in the illustrations of the species.

The crura have the general form of those in WALDHEIMIA, extending in a long recurved loop, with long processes descending into the ventral valve, between which and the apex the crura are united by a transverse band, differing in this respect from that genus, while the muscular impression and extended beak offer other distinctions.

I have thought it desirable, therefore, to continue the name CRYPTONELLA to include these two authentic species; while the other species are included under it from their general form.

I have continued the *Terebratula lens* under that genus, without knowing its internal structure, but from its external similarity with those which have proved to belong to that genus.

These investigations have clearly shown how difficult, or even impossible, it is to refer to their proper generic relations these fossils from external form and character alone.

Cryptonella rectirostra.

PLATE LXI.

Terebratula rectirostra : Hall, Thirteenth Report on the State Cabinet, p. 88. 1860.
" " Id. Referred to Cryptonella in Fourteenth Report, p. 101. 1861.
Cryptonella rectirostra : Id. Sixteenth Report on the State Cabinet, p. 44. 1863.

Shell elongate-ovate, subovate or elliptical; the greatest width anterior to the middle : valves subequally convex, rounded or subtruncate at the base.

Ventral valve regularly arcuate, most convex in the middle, sometimes a little flattened at the base : beak much extended beyond the opposite valve, moderately incurved and truncated by a round foramen, which is completed on the lower side by two narrow deltidial pieces. Shell abruptly inflected from the umbonal slopes to the cardinal margin.

Dorsal valve scarcely more convex than the opposite, gibbous towards the umbo, and regularly curving to the base and baso-lateral margins; beak closely incurved beneath the deltidial plates of the opposite valve.

Surface marked by fine concentric lines of growth, and often at some what regular intervals by imbricating lamellæ. Structure finely punctate.

In the dorsal valve, the muscular impressions are narrow and elongate; and in the ventral valve the teeth are strong, and the muscular imprint elongate, with strong vascular markings extending nearly to the base of the shell. The crura are extended below the middle of the length of the shell and then abruptly recurved, reaching backwards more than half way to the apex : the crural processes penetrate deeply into the ventral cavity, and between these and their origin the crura are connected by a transverse band.

This species varies from individuals of less than half an inch in length to those of nearly an inch and a half. In the older shells, and sometimes in the younger ones, the lamellose concentric lines are very conspicuous.

Geological formation and localities. This species occurs in the Hamilton group, at Bellona in Yates county; on the shore of Canandaigua lake; at York, Moscow and Geneseo in Livingston county; at Hamburgh on the shore of Lake Erie, and elsewhere in Western New-York.

Cryptonella planirostra.

PLATE LXI.

Terebratula planirostra : Hall, Thirteenth Report on the State Cabinet, p. 89. 1860.
" " Id. Referred to Cryptonella in Fourteenth Report, p. 101. 1861.
Cryptonella planirostra : Id. Sixteenth Report on the State Cabinet, p. 44. 1863.

Shell subovate or elliptical; the front often truncate, giving a subpentagonal outline; the greatest width near the middle of the shell; the length and width about as six to seven or eight. The depth of the two valves, in well-formed specimens, is about equal to half the length.

Ventral valve in old shells gibbous, the greatest convexity above the middle, often slightly flattened towards the beak, which is moderately incurved and truncate by a round foramen, limited below by conspicuous deltidial pieces, abruptly inflected along the umbonal slope, often leaving an angular ridge, and the space between it and the hinge-margin flat or concave; often slightly flattened below the middle, and regularly curving to the sides.

Dorsal valve considerably shorter than the opposite, more convex or gibbous, the greatest convexity at or a little above the centre, curving to the sides and front where it is sometimes flattened : beak incurving beneath the deltidial plates of the opposite valve.

Surface marked by fine rounded concentric striæ, which in old shells are disposed in broader belts of imbricating lamellæ. Shell-structure punctate.

The crura reach below the middle of the length of the shell, approaching each other very closely, and abruptly recurved for a distance about half their length : they are united near their bases by a transverse band.

The larger well-marked individuals have a length of about one inch; and a single specimen, apparently of this species, is nearly two inches long.

In the young or half-grown shells, the valves are moderately convex and the beak scarcely incurved, while there is no perceptible truncation in front. The flattening of the umbo and umbonal slopes are not constant characters, and we have regularly ovate forms with every part limited by curved lines.

I have received from Dr. G. A. Williams, formerly of Hardy county, Virginia, several casts of a species of this genus, which I have referred to this. One of those figured upon the plate is proportionally more elongate than the New-York forms; but the shell has been abruptly incurved on the umbonal slopes, flattened on the lower part of the ventral valve, and obliquely subtruncate in front.

Geological formation and localities. This species occurs in the Hamilton group on the shores of Seneca and Canandaigua lakes, at Moscow, York and Geneseo in Livingston county, and at Pavilion in Genesee county, New-York.

Cryptonella iphis (n. s.).

PLATE LXI.

Shell elongate, subcylindrical.

Ventral valve more convex than the dorsal, regularly arcuate from beak to base, the greatest convexity about the middle of its length, abruptly rounded or subtruncate in front. Beak much extended beyond that of the opposite valve, and slightly arcuate.

Dorsal valve somewhat depressed-convex in the middle, and shortly curving to the margins; the upper two-thirds of the length of the valve almost equally convex.

Surface concentrically striated, with a few strong undulations towards the front, in the cast. Shell-structure punctate.

Length one inch; width less than three-fourths of an inch.

The specimen is almost an entire cast, and is referred to the Genus Cryptonella from the elongate form, moderately incurved beak, and character of muscular impressions. The punctate structure of the shell indicates its position among the Terebratulidæ.

Geological formation and locality. This shell occurs in the Corniferous limestone, near Cayuga in Canada West.

Cryptonella? lincklæni.

PLATE LX.

Terebratula lincklæni : Hall, Thirteenth Report on the State Cabinet, p. 88. 1860.
" " Idem, referred to Cryptonella ; Fourteenth Report on the State Cabinet, p. 101. 1861.
Cryptonella lincklæni : Idem, Sixteenth Report on the State Cabinet, p. 44. 1863.

Shell ovate or subelliptical, usually broader below the middle, varying from moderately convex to very gibbous and sometimes subcylindrical; front rounded, subtruncate, or a little depressed.

Ventral valve varying from moderately convex to gibbous, somewhat regularly arcuate in longitudinal outline, sometimes a little flattened towards the front or marked by a narrow mesial depression. Beak more or less abruptly incurved, and truncate by a foramen of moderate size : umbonal slopes rounded or subangular, and concave towards the cardinal margin.

Dorsal valve varying from moderately convex to gibbous; the greatest convexity about the middle of the length, and thence curving regularly to the sides and base.

Surface marked by fine concentric striæ of growth, which are sometimes crowded together towards the front, causing a thickening of the shell. Shell-structure distinctly punctate.

The internal structure has not been determined, and I therefore refer it with doubt to the Genus Cryptonella.

This species presents some variety of form, from subelliptical to broad-ovate. The length of a large individual is a little more than three-fourths of an inch, with a width of five-eighths of an inch and a depth of three-eighths; while another form, which I refer to the same, has a length and width of half an inch, with a depth of a little more than a quarter of an inch. Some of the smaller individuals are a little more than a quarter of an inch in length.

This species is common in certain beds; and for the most part is readily recognized. In the less gibbous specimens, it resembles the *C. planirostra*, but the beak is more incurved, and there is less angularity of the umbonal slope, while the outline is more regularly rounded. In a crushed and distorted condition, it is not readily distinguished from *C. rectirostra*.

Geological formation and localities. This species occurs in the Hamilton group at Burchard's quarry near Hamilton in Madison county, and is of frequent occurrence at Delphi falls in Onondaga county, and near Kelloggsville in Cayuga county, whence I have formerly received it from Prof. HOPKINS of Auburn. It is also found in some other localities, and a single specimen from Thunder bay in Michigan is of this or a closely allied species.

Cryptonella (Terebratula) eudora (n. s.).

PLATE LXI.

SHELL broadly ovate, rounded in front; apex obtuse.

VENTRAL valve gibbous in the central and upper part, moderately convex in the lower part, and sometimes flattened towards the front; tapering abruptly to the beak, which is obtuse, little extended beyond the opposite valve, slightly incurved, and truncated by a rounded foramen.

DORSAL valve depressed-convex, often gibbous in the middle above; beak incurved into the cavity below the deltidial plates.

SURFACE concentrically striate, with crowded lamelliform ridges towards the sides and front. Shell-structure punctate.

The prevailing length is from one inch to nearly an inch and a half; the width, from three-fourths of an inch to an inch and a quarter. The separated dorsal valves are often of equal length and width.

This species is proportionally broader than the prevailing forms in the Hamilton group, though varying little from some specimens of the *C. planirostra*, which has a more extended beak and flattened cardinal slopes.

Geological formation and localities. This species occurs in some dark argillaceous sandstones in the Chemung group, near Ithaca, whence most of the specimens have been received. It is found also at Chemung-narrows, Chemung county, New-York. Specimens of similar form and proportions occur in the Waverly sandstone of Licking county, Ohio; and a specimen collected by Mr. WHITFIELD at Rockford, Iowa, has essentially the same form and proportions.

Collections made near Ithaca, while these pages are going through the press, show the species to be comparatively abundant in some calcareo-arenaceous beds, which, in their weathered decomposing portions, have left the casts of the interior.

Genus Centronella (Billings, 1859).

Recognizing the Genus Centronella as founded on *C. glans-fagea*, and taking the illustrations of the interior as given in the Sixteenth Report on the State Cabinet, p. 47, as the true representation of the loop, we feel warranted in uniting two or three other forms in the same generic relation, from the general similarity of form, and compact shell substance, which is finely punctate. With our present knowledge, the genus begins its existence in the Schoharie grit, and is known in the Upper Helderberg limestone and in the Hamilton and Chemung groups. It is not improbable that the genus may have a greater vertical range, and that it will be found among the terebratuloid forms of the Carboniferous period. The characteristic species, known in New-York, have the dorsal valve flattened or concave; but the *C. julia* of Winchell has an oval form and convex dorsal valve, giving no indication, from these features, of its generic relations.

Centronella glans-fagea.

PLATE LXI.

Rhynchonella glans-fagea : Hall, Tenth Report on the State Cabinet, p. 125. 1857.
Centronella glans-fagea : Billings, Canadian Naturalist and Geologist, pp. 131 & 132. April 1859.
" " Hall, Sixteenth Report on the State Cabinet. 1863.
(The species illustrated and discussed on pages 45, 46 and 47.)

Shell small, broad-ovate or subquadrate; the sides often sloping from near the middle to the apex at an angle of about 85°; the front rounded; the valves very unequal.

Ventral valve much larger than the dorsal, very prominent, often subcarinate along the middle and curving very abruptly to the lateral margins, regularly arcuate from beak to base. Beak much extended beyond that of the opposite valve, strongly incurved, bringing the apex above the plane of the margin of the dorsal valve.

Dorsal valve usually convex in the upper part, concave in the middle by a broad undefined sinus, which, towards the front, often involves the entire width of the valve : beak not incurved.

Surface smooth, or with faint concentric lines of growth : shell compact and very finely punctate. The shell varies from three-tenths to four-tenths of an inch in length ; the width usually more than three-fourths as much, and sometimes nearly equal to the length.

The interior of the ventral valve shows two strong teeth, at some distance below the apex, with strong dental lamellæ. The interior of the dorsal valve shows the bases of the crura to be very thick and strong, entirely divided at the centre, and each supporting a thin filament, which becomes broader below and sends off a spur into the ventral cavity; and thence curving inwards, the outer margins are united and produced along the line of junction in a slender elevated carina, which extends forward in a slender free point. The muscular imprint is oval, and divided along the centre.

The casts of the interior preserve the impressions of the features described, and are readily recognized by the slender incurved filling of the rostral cavity.

This species presents considerable variety in its form and proportions. The dorsal valve is often gibbous in its upper part, with or without a median sinus, which becomes developed below the middle. In other individuals, the gibbous upper part of the valve is marked by a narrow sinus, which becomes broader below ; and in others, the dorsal valve is concave throughout its entire length and breadth, except a slight convexity along the cardinal slopes. The front is sometimes truncate or sinuate, and not unfrequently pointed from the extension of the mesial ridge of the ventral valve, and the corresponding sinus of the dorsal valve.

In a single specimen from the Schoharie grit, the dorsal valve is quite flat ; and another from the Corniferous limestone has the ventral valve scarcely subangular in the middle, and the dorsal valve regularly and gently convex.

Geological formations and localities. This species occurs in the Schoharie grit, at numerous places in Albany and Schoharie counties, and particularly near Clarksville and Schoharie. It is likewise found in the Corniferous limestone at numerous localities, but is usually somewhat rare in this rock in New-York. It occurs in the same horizon in Canada West and in Ohio.

Centronella alveata.

PLATE LXI.

Rhynchonella? alveata : Hall, Tenth Report on the State Cabinet, p. 124. 1857.

Compare *Centronella hecate* : Billings, Canadian Journal, May 1861.

Shell elongate-oval or subrhomboidal; length much greater than the width; sloping from above the middle to the prominent beak of the ventral valve, the included angle being about 70°. Anterior margin subtruncate for about one-third the width of the shell.

Ventral valve prominent in the middle, from a broad, undefined, abruptly or scarcely subangular mesial elevation : the slope thence to the sides below the middle is scarcely convex, and above the middle the sides are more convex, with a little flattened expansion close to the margin; the longitudinal outline gently arched; the beak prominent, erect or slightly arching.

Dorsal valve, in the upper part, convex at the sides and depressed in the middle into a wide undefined sinus, which, below the first third of the length, embraces the entire width of the valve, giving it a trough-shaped aspect.

Surface smooth : shell compact, punctate.

Length of specimen, one inch.

This species, described by me in 1857, has so much the form and character of *C. hecate*, Billings, described in 1861, that I can scarcely doubt the identity of the two; the only difference being in the size of the specimens.

Geological formation and locality. The original specimen of this species was given to me many years since by Mr. W. H. Pease, as coming from the Onondaga limestone; but the particular locality is unknown.

Centronella impressa.

PLATE LXI.

Centronella impressa : Hall, Fourteenth Report on the State Cabinet, p. 102. 1862.
" " Idem, Fifteenth Report on the State Cabinet, p. 160–161. 1862.

Shell subovate in outline, sometimes extended in front, rarely subsinuate; width and length about as seven to nine.

Ventral valve convex, prominent or subangular along the middle and abruptly curving to the sides; longitudinal outline slightly arched, sometimes nearly straight : beak nearly erect and truncated by a rounded foramen, which is limited below by deltidial plates.

Dorsal valve much shorter than the ventral, in the upper part convex at the sides, and flattened or depressed in the middle and towards the front, which is much produced and curves downwards to occupy the sinuous outline of the ventral valve. Sometimes the dorsal valve is nearly flat, with an impressed line down the centre, and sometimes flattened in the upper part and convex in the lower part : beak not incurved.

Surface with fine concentric striæ and nearly obsolete remains of very fine radiating striæ, which are visible only under a lens. Shell compact; texture punctate.

The interior of the ventral valve shows a very strong tooth on each side at the base of the fissure, and nearly one-third the length of the valve from the apex. The interior of the dorsal valve shows the dental sockets and a remarkably strong thickened hinge-plate, which is concave in the centre, the margins extended and inclosing an oval muscular area, which is divided by a low longitudinal septum. Outside of the muscular area there is a low longitudinal ridge extending to the anterior margin of the shell. [In these features, it resembles, but is very distinct from, the interior of the dorsal valve of *C. glans-fagea*.] The crura have not been observed.

This species has the general form and aspect of *C. glans-fagea;* differing, however, in a very characteristic manner. It has a similar compact and finely punctate texture, and the propriety of referring it to the same genus can scarcely be doubted.

Geological formation and localities. This species occurs in the Hamilton group: on Coshong creek near Bellona in Yates county; at York in Livingston county; at Pavilion in Genesee county; and at Hamburgh on the shore of Lake Erie, in Erie county.

Centronella glaucia (n. s.).

PLATE LXI.

Shell ovate or ovoid, gibbous, with the front rounded or subtruncate

Ventral valve gibbous, highly arcuate longitudinally, more elevated in the middle and sometimes subcarinate, curving abruptly to the sides: beak strongly arched.

Dorsal valve convex on each side and abruptly bent downwards at the margins, slightly depressed in the middle of the upper part, with a more distinct sinus towards the front.

Surface marked by fine concentric striæ, which at intervals are crowded into subimbricating folds or ridges. Shell compact; structure punctate.

The cast of the ventral valve shows a deep arching rostral cavity, and strong muscular imprints below, with deep curving dental lamellæ.

The specimens are nearly three-fourths of an inch in length, with a width of more than half an inch.

Geological formation and locality. This species occurs in some compact beds of the Hamilton group in Schoharie county; the particular locality unknown.

In the preceding arrangement of the materials in the collections forming the subjects of this volume, there has been comparatively little difficulty in assigning to each genus its approximate relations; and from the ORTHIDES onward, there is a very natural succession among the genera. In this arrangement, however, two genera, TROPIDOLEPTUS and VITULINA, are left out of the series; nor does there appear to be any place where either one of these can be naturally introduced.

We had originally supposed that TROPIDOLEPTUS would find its place among the Strophomenidæ; but there have been at all times some important objections to placing it in this relation, while later discoveries have rendered such a reference unnatural. Notwithstanding the concavo-convex form, area, and large fissure under the beak of the ventral valve, still the punctate structure of the shell and the character of the crura seem to indicate its relations to be with the Terebratulidæ; and I have accordingly placed it in an order following the authentic genera of this family.

GENUS TROPIDOLEPTUS (HALL).

[Gr. τροπις, *carina*; λεπτος, *tenuis*.]

TROPIDOLEPTUS : HALL, Report on the State Cabinet. 1857.
" ID. Palæozoic Fossils. 1857.
" ID. Twelfth Report on the State Cabinet, p. 31. 1859.

SHELL transversely suboval or semielliptical, concavo-convex : hinge-line extended, not crenulate; articulating by teeth and sockets.

VENTRAL valve convex, with a distinct area, and wide fissure beneath the beak. Dental lamellæ distinct from the margin of the fissure, crenulate.

DORSAL valve concave, with crenulate dental fossets; a strong cardinal process, with diverging lobes in the interior, which support slender crura that converge to and unite with the median crest.

Surface plicate : shell-structure punctate.

The typical species of this genus is a concavo-convex shell, having the general form of Leptæna and Strophomena, and was originally described by Mr. Conrad as *Strophomena carinata*. It differs from all the genera of Strophomenidæ in both external and internal characters, and, for these reasons, has been separated. The shell is externally strongly ribbed, and the texture is finely punctate throughout its substance. The ventral area is well defined, narrow and linear. The fissure or foramen is very large and wide, and is excavated above the area line, coming quite up to the beak, and sometimes even including the apex which is worn away or absorbed.

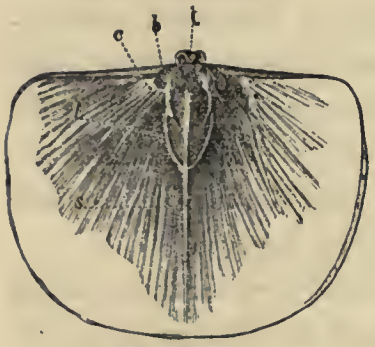
The teeth, which are a little separated from the margins of the foramen and not continuations from it, are strong and thickened below, while they are deeply crenulated on the summit and exterior margins. There is a narrow low median ridge in the cavity of the valve; and the divaricator muscular impressions are broad, and flabelliform. The occlusor muscular impressions have not been satisfactorily observed.

The dorsal valve has a narrow area, and a wide and strong cardinal process which nearly or quite fills the foramen of the opposite valve. This process is often simple exteriorly, above the limit of the smooth or striated pseudo-deltidium which covers it near the hinge-line; but just within the valve it is broadly grooved in the middle, usually with two small deep pits just within the external smooth callosity, and on each side there is a groove and accessory lobe, frequently not conspicuous. The divisions made by the median groove diverge and terminate below in obtuse processes which have some similarity with the bases of crural processes in Orthis, but have more analogy with the Terebratulidæ. These processes are sometimes clearly broken at their termination, but are often smooth as if the roughened surface had been cicatrized during the life of the animal. Below these forks of the process there is a narrow median crest or septum which reaches beyond the middle of the valve, and sometimes nearly to the front. From the limbs of the thickened divergent processes there proceed slender crura which, at first bending

slightly outwards, send off a short spur into the ventral cavity and are thence directed forwards, and gently curving, join the median crest, to which they are attached, forming a loop of peculiar character. The occlusor muscular impressions have rarely been seen with any degree of distinctness; but the depressions just at the termination of the crural processes, and on each side of the median ridge, are striated; and this striation often extends in a wide flabelliform expansion, probably due to vascular impressions. Towards the margin, the interior of both valves is strongly pustulose.

The accompanying wood-cuts illustrate the parts referred to above.

FIG. 1.
Interior of the dorsal valve.



j. Cardinal process.
b. Crenulated teeth-sockets.
c. Crural processes.
l. Loop.
s. Septum.

FIG. 2.
Longitudinal section of the dorsal valve.

j. Cardinal process.
b. Tooth-socket.
c. Crural processes.
l. Loop.
s. Septum.

In the punctate texture of this shell, it differs from either of the Genera LEPTÆNA, STROPHOMENA or STROPHODONTA; but this might not be an objection to admitting TROPIDOLEPTUS into the family, were the other characters coincident. The area is longitudinally striated, and presents a different aspect from any of the STROPHOMENIDÆ, but has analogy with some of the Orthides. The teeth are not extensions of the lamellæ bounding the foramen, but distinct from it and deeply crenulate or lobed, and inserted into corresponding crenulate sockets in the dorsal valve. The form of muscular impressions, so far as known, is not very dissimilar to those of STROPHOMENA or ORTHIS.

In comparing the form of the cardinal process and its appendages, we shall find it almost entirely similar to that of LEPTOCŒLIA, as shown in two authentic species (*L. flabellites* and *L. fimbriata*), and the muscular impression of the ventral valve is quite like that of the same species.

The exterior extremity of the cardinal process presents considerable variety of aspect, when a large number of individuals are examined. In some of them this part, if stripped of the external callosity of pseudo-deltidium, would have the main process bilobed, with a sinus a little below the apex, and an accessory lobe on each side similar to some of the species of PRODUCTUS.

Tropidoleptus carinatus.

PLATE LXII.

Strophomena carinata : CONRAD, Ann. Geol. Rep. p. 64. 1839.
Leptæna laticosta : HALL, 1843.
" " of OWEN and others.
Tropidoleptus carinatus : HALL in Tenth Report on the State Cabinet, p. 151. 1857.
TROPIDOLEPTUS : Genus described and illustrated in Twelfth Report on the State Cabinet, p 31. 1859.

SHELL concavo-convex, semielliptical, the length sometimes nearly equalling the width : hinge-line equalling, greater, or less than the width of the shell, and the cardinal extremities sometimes rounded so as to give the shell a broadly oval form ; the sides are sometimes nearly straight, and the front broadly rounded.

VENTRAL valve convex, broadly subcarinate along the middle, and sloping in a flattened curve to the lateral margins and front, which is sometimes slightly truncate or emarginate : cardinal extremities deflected, abruptly incurved at the umbo, and the apex often imperfect from the encroachments of the foramen. Area from half a line to about one line in width ; its margins parallel to near the extremities, where it slopes suddenly down from the outer margin. The area is longitudinally striate, and indented by a very wide foramen.

DORSAL valve moderately concave, sometimes nearly flat, often with a median depression or sinus which becomes conspicuous below the middle of the valve : apex small, projecting a little beyond the hinge-line. There is a narrow area, interrupted in the middle by a wide pseudo-deltidium which covers the extremity of the cardinal process.

SURFACE marked by about eighteen to twenty broad, simple, rounded plications which are wider than the spaces between them ; the central one on the ventral valve is broader and more elevated than the others, while there is a corresponding wider and deeper depression in

the middle of the dorsal valve. In rare instances, the plications are bifurcated. Fine undulating concentric striæ cover the surface, and a few stronger imbricating lamellæ mark the form of the shell in its stages of growth.

The interior structure has been noticed under the generic description.

Specimens from certain localities show no appreciable difference in the size of the costæ, and there is no distinct carination in the middle.

In its young state, the shell resembles *Chonetes deflecta*, but usually is proportionally longer; and the absence of spines, as well as its punctate surface, are distinctive features.

The illustrations, figures 2 *a*, *b*, *c*, are of unusually elongate forms, where the median plication is not perceptibly larger than the others.

Figures 3 *a*–*k* present the principal varieties of form and size of the species; and figure 3 *l* shows a dorsal valve with bifurcating plications.

Figure 4 is a form with more numerous and finer plications, but in other respects does not show important differences.

Figure 3 *m* shows the general aspect of the area and foramen, with the cardinal process. The remaining figures show the interiors of ventral and dorsal valves, and the casts of the same as they occur in the arenaceous beds.

When extremely magnified, the surface presents the structure shown in figure 3 *s*.

A similar or identical species has been recognized in Europe, and is published under the name of *Leptæna laticosta* in the Bull. de la Soc. Geol. de France, Tome iv, pa. 325, pl. 3; but it is there represented as having about thirty-two plications, a greater number than any of our specimens, and it will probably prove a distinct species of the same generic type.

Geological formation and localities. In the Hamilton group in Schoharie county, and extending throughout the State of New-York from near the Hudson-river to Lake Erie. Some of the principal localities are in Schoharie and Otsego counties; on the shores of Cayuga, Seneca, and Canandaigua lakes, and at Darien and Eighteen-mile creek. It is likewise known in rocks of the same age in Illinois and Iowa.

Tropidoleptus occidens.

PLATE LXII.

Tropidoleptus occidens : Hall in Thirteenth Ann. Report on the State Cabinet, p. 91. 1860.

Shell concavo-convex, semielliptical, about as long as wide : apex of the ventral valve extending beyond the hinge-line. Area linear, appa-

rently equal on the two valves. Surface marked by twelve or fourteen angular plications on each valve; of these, two central ones on the ventral valve are a little elevated, and two others on the dorsal valve correspondingly depressed.

So far as known, this shell offers differences by which it is readily separated from the preceding species. It may, however, prove to be only a variety.

Geological formation and locality. In limestone of the age of the Hamilton group, at Iowa city, Iowa. From Rev. W. H. Barris.

The Genus Vitulina was founded upon a species peculiar in form and internal characters, and no others of the same type have yet been observed. It presents many features in common with Orthis; and among these may be mentioned the area on each valve, smaller on the dorsal than on the ventral, and the wide fissure of the ventral valve, partially filled by the cardinal process of the opposite valve. The cardinal process itself is unlike that of Orthis, but the strongly divergent teeth-like crura are similar; and these, from their great divergence, would scarcely admit of the terebratuloid loop, or of spires, unless arranged as in Atrypa. The punctate texture is as much like Orthis as it is like Terebratula; while the muscular impressions are similar to those of Orthis. In its punctate texture and papillose surface, it reminds one of Spiriferina, but its internal structure is quite different.

With our present knowledge of its characters, I am compelled to express a doubt as to its family relations; and I have therefore placed it at the end of the series.

Genus Vitulina (Hall).

Vitulina : Hall, Thirteenth Report on the State Cabinet, p. 72. 1860.

Shell plano-convex : hinge-line extended : valves articulating by teeth and sockets.

Ventral valve gibbous, with a high area, and large triangular fissure. A callosity or false area in the bottom of the fissure. Dental lamellæ thick and strong.

Dorsal valve depressed-convex, with a scarcely perceptible area; a strong cardinal process, which is conspicuous at the base of the fissure in the closed valves.

Surface plicated, papillose : shell-structure punctate.

Vitulina pustulosa.

PLATE LXII.

Vitulina pustulosa : Hall in Thirteenth Report on the State Cabinet, p. 82. 1860.

Shell subplano-convex, semielliptical : hinge-line equalling or a little less than the width of the shell : surface marked by a few strong plications, and covered by minute papillæ, which appear like the bases of setæ. Substance of the shell finely punctate.

Ventral valve very convex; the apex a little arcuate, subangular in the middle above, and the elevation continued in a broad fold which is at first flattened and then becomes grooved or duplicate below, with four or five rounded or subangular plications on each side; the area much elevated, and the margin sloping rapidly from the apex to the cardinal extremities : foramen large and wide, being half the length of the area, and reaching to the apex; deltidial pieces or pseudo-deltidium unknown.

Dorsal valve flat or slightly convex, with a wide mesial depression which is nearly flat in the bottom, and in larger specimens has a shallow groove in the middle towards the front. The plications on the sides correspond with those of the ventral valve. There is a narrow scarcely perceptible area.

Surface covered by minute papillæ. Substance finely punctate.

In the interior of the ventral valve, the margins of the foramen are extended in two strong teeth, which are supported on the lower and lateral margins by a callosity of the shell. Beneath the apex, a strong callosity or false area extends across the valve and reaches to the base of the teeth. This callosity is visible in the foramen, and from its lower margin proceeds a slender median septum (fig. 1 *h*). On each side of this septum, at its junction with the transverse callosity, there is a small pit for the occlusor muscle; and beyond this a broad flabelliform area for the divaricator muscular attachments. These features are shown in the cast, fig. 1 *i*.

In the dorsal valve, there is a strong median ridge or septum which terminates in a slightly lobed cardinal process; on each side of this are the crural processes, and between these and the margin are the teeth sockets.

Figures 1 *a*, *b*, are of the largest specimens observed. Figures 1 *c* and 1 *d* are enlarged, showing the character of the plications and the pustulose surface. Figures 1 *e*, *f*, are enlargements from an entire specimen : the profile, as given, represents the dorsal area as proportionally too wide. The interiors of the valves and the cast of the ventral valve are enlarged two diameters.

Geological formation and localities. This species was first observed in a single individual among specimens collected at Canandaigua lake, and was afterwards found at York in Livingston county. More recently, and since the engravings were completed, Mr. Whitfield has found the fossil in considerable numbers near Tully and at Tinker's falls in Onondaga county.

ADDENDA.

Trematospira? nobilis.

PLATE.

Rhynchospira nobilis : HALL, Thirteenth Report on the State Cabinet, p. 83. 1860.

THIS species was omitted in its proper place, in the hope of being able to determine its true relations; but the result has not been quite satisfactory. It appears, however, to be more nearly related to the Genus TREMATOSPIRA than to RHYNCHOSPIRA; and it may be found to differ from either of these when the internal characters shall be fully ascertained.

SHELL large, broadly subovoid; surface plicated.

VENTRAL valve with a broad mesial sinus; the beak large and truncated by a large round foramen, the lower side of which is bounded by the summits of the deltidial plates: margins of the valve subalate a little below the beak.

DORSAL valve the more gibbous, with a broad, moderately elevated mesial fold.

SURFACE marked by numerous angular elevated plications, which are sharply crenulated on the summits; the sides and intermediate spaces finely and evenly striated. On the mesial fold there are from nine to eleven plications, and a corresponding number in the sinus.

The interior of the ventral valve shows a strong tooth on each side at the base of the fissure; the rostral cavity is limited by a callosity, and the muscular area is strongly marked and somewhat quadrate in form, as far as observed.

The interior of the dorsal valve shows strong crural processes extending from the hinge-line for a short distance, when they become slender and flattened; and below this they curve and send off a process towards the centre of the shell, as in others of the genus, and similar to that of TEREBRATULA.

Geological formation and locality. In the Hamilton group; at Darien, Genesee county, New-York.

Genus Pholidops (Hall.)

In 1859, I proposed the name Pholidops for some minute fossils belonging apparently to the family Craniadæ, but differing from the true Crania in being free or unattached to other bodies, so far as is known. Since that time my attention has been called to the figures of *Crania antiquissima* of Eichwald, as given by de Verneuil, in the *Geology of Russia and the Ural Mountains*, vol. ii, plate 1, figs. 12, *a*, *b*, *c*. These are cited by McCoy as illustrations of typical form of Pseudocrania. In the figure 12 *a*, we have the characteristic muscular impression of Pholidops; fig. 12 *b*, can scarcely belong to the same species since the apex is subcentral. The figures of *Pseudocrania divaricata* given by McCoy, (*British Palæozoic Fossils*,) illustrate a different type; the exterior is represented as radiatingly striate with a distinct area like Trematis, while the interior presents four muscular pits as in Crania, and quite unlike the Pholidops of our strata. Prof. McCoy has cited both the above species as typical forms, but in the present state of our knowledge I am not prepared to abandon the Genus Pholidops.

Pholidops arenaria, (n. s.).

PLATE III, FIG. 10. See note, page 32.

Shell rather above the usual size, subcircular, discoid; beak submarginal and slightly elevated; front margin expanded and flattened.

Surface unknown; interior characterized by a large subcentral muscular scar, which in the cast is much deeper on the front margin, and divided by a narrow septum.

This species closely resembles *P. oblata* of the Schoharie grit, but differs in being more nearly circular and in having a much larger area occupied by the muscular impression. The largest specimens measure a little more than one-fourth of an inch in length.

Geological formation and locality. In the Oriskany sandstone in the town of Knox, Albany county, N. Y.

Pholidops oblata (n. s.).

PLATE III, FIG. 10.

SHELL suborbicular, somewhat flattened on the upper margin, discoid or depressed convex; the length and width about equal; muscular area of the interior small, circular, and divided through the middle by a longitudinal septum. External surface unknown.

In general aspect this species somewhat resembles *P. arenaria*, but differs very materially in the form of the muscular impression.

Geological formation and locality. In the shales of the Hamilton group, at Carter's Mills, four miles south of Aurora, Onondaga county, N. Y.

Pholidops? linguloides (n. s.).

PLATE III, FIG. 11.

SHELL broadly ovate, with an obtusely pointed beak, which is apparently terminal.

SURFACE covered by rather closely arranged, strongly lamellose concentric lines of growth, which reach the margin of the valve near the beak.

Length of shell sixty-two hundredths of an inch; greatest width, fifty-six hundredths of an inch.

This species differs from any of the described forms of the genus PHOLIDOPS in its terminal beak and subnacreous shell. There may be some doubt regarding the propriety of its reference to this genus, but at present no other group seems so well adapted to its reception.

Geological formation and locality. In concretionary layers of the Hamilton shales, on Canandaigua Lake, New York.

Strophomena rhomboidalis?

PLATE XV, FIGS. 15, 16.

SPECIMENS of shells having the characters of this species have been obtained among a collection from Mallet's Creek, two miles north of York

Centre, Medina county, Ohio, in rocks pertaining to the Waverly group. The specimens present no characteristic differences from those of the Lower Helderberg group, or any modifications which cannot be detected among the collections of specimens from that group. Individuals may be selected from any of the formations that will show strong and well marked differences, either from these under consideration, or from each other, but a series connecting the extremes from either the Niagara or Lower Helderberg groups will contain individuals having the same characters with those presented by the Ohio specimens.

The occurrence of this species in this Geological position, is the more interesting since thus far, it has not been found in the Hamilton or Chemung groups of New York.

Strophodonta subdemissa.

PLATE XVII, FIGS. 2 *h*, 2 *i*.

Strophodonta subdemissa: HALL, Tenth Report on the State Cabinet, p. 145.
Strophodonta demissa: HALL, Geological Report of Iowa, Vol. I, part 2, p. 495, pl. 5, *a*, *b*, *c*. *d*
Strophodonta dimosa ? [demissa] OWEN. Geol. Survey of Wisconsin, Iowa, Minnesota. Explanation of Table III A, fig. 14.

SHELL semicircular in outline, with more or less extended and sometimes mucronate cardinal extremities.

VENTRAL valve depressed convex, somewhat regularly arching from beak to base; area narrow, crenulated.

DORSAL valve concave, nearly following the curvature of the ventral valve; area linear, crenulated.

SURFACE marked by strong radiating striæ, which are increased by interstitial additions becoming finer and more numerous near the margin in adult individuals. The striæ are themselves longitudinally striate on well preserved specimens, having from three to six striæ on each of the larger ones, near the middle portions of the ventral valve.

I have hesitated to continue this as a distinct species, and have so indicated on page 114 of this volume. The Western specimens, however, show a constant difference in form and in certain peculiarities of the striæ. While the New York

forms are usually longer than wide, the Western ones are as long as wide, and sometimes wider, and the cardinal extremities are usually extended and frequently mucronate. They are likewise less ventricose, the space between the valves being less, and the muscular impressions not so strongly marked. In these respects, however, the New York specimens of the Chemung group more nearly resemble the Western ones.

Geological formation and locality. In rocks of the age of the Hamilton group, at Rock Island, Ill., and at Independence and New Buffalo, Iowa.

Spirifera maia.

PLATE LXIII, FIGS. 6–13.

Athyris maia: Billings. Canadian Jour. Ind. Sci. and Arts, May, 1860, p. 276.

Shell below the medium generic size, ventricose, with rounded cardinal angles, giving a longitudinally ovate outline, with a depressed subglobose form; hinge line very short; cardinal area narrow and sometimes hidden by the beak.

Dorsal valve suborbicular, moderately ventricose, with a distinctly elevated rounded mesial fold.

Ventral valve more ventricose than the opposite, with a large, tumid, incurved beak, and a moderate, subangular mesial sinus.

Surface destitute of plications, but marked by more or less distinct concentric striæ of growth.

This species is of the type of, and in some conditions greatly resembles, *S. lineata*, of the Coal measures, but differs in the projecting beak and more ventricose dorsal valve, as also in the surface markings. It is also very similar to *S. subumbona*, of the Marcellus shale, but is a larger form, and differs in the shorter hinge line, larger beak and more ventricose dorsal valve, and in the surface markings.

Geological formation and locality. In the Corniferous limestone of Ohio and Canada West. The specimens figured are from Rev. H. Herzer, of Columbus, Ohio.

Spirifera whitneyi.

Spirifera whitneyi: HALL. Geological Report of Iowa, p. 502, plate 4, f. 2. 1859.

This species is referred to on page 245, as derived from beds of the age of the Hamilton group, in Iowa. More recent observations, with pretty extensive collections made in several localities in Iowa, by Mr. R. P. Whitfield in 1866, have led to the conclusion that this species, together with its associates in the same locality, are of higher beds than those of the Hamilton group and should properly be referred to the age of the Chemung.

Some further notice of the species thus associated, will appear in the State Cabinet Report.

Spirifera mesastrialis.

PLATE LII, FIGS. 14–22,

This species, in its varieties of form, has heretofore been referred to the Chemung group only. More recent collections, with better knowledge of the limits of the Chemung and Hamilton groups in the eastern part of the State, have shown its occurrence in the two formations. The specimens from Schoharie county are from rocks of the Hamilton group, and are separated from those in Delaware county by almost non-fossiliferous beds of several hundred feet in thickness. It is a little remarkable that while the geographical range of the species is less than two hundred miles, its vertical range should be so very great.

Rhynchonella (Stenocisma) contracta *var.* saxatilis.

PLATE LIV A, FIGS. 44–51.

AMONG the collections from Rockford, Iowa, there are some specimens of RHYNCHONELLA, which possess many of the characteristic features of *R. contracta* of the New York Chemung group, and also those of *R. eximia* of the same formation. The examples figured on plate 54 A, figs. 44–49, have much the appearance of the former species, except in size, while the

specimens, figs. 50 and 51, are of the type of *R. eximia*, of small size. Although there are few examples in the collection, they still show a gradual increase in the plications, from those having the least to those with the greatest number, without any possible means of drawing a line of separation between them; while among the New York specimens the separation is comparatively easy. Considering these facts, the specimens are for the present referred with some doubt to *R. contracta*, until more material can be obtained, offering better means of comparison.

Terebratula lincklæni *var.*

PLATE LX, FIGS. 32–37.

Compare *T. Traversensis*, Winch. Rep. on Grand Traverse region, p. 95. 1866.

Among some Terebratuloid shells obtained from Thunder Bay, Michigan, there are a few having some resemblance to *T. lincklæni*, but differing in some points which, if constant among a larger number of specimens, might prove to be of specific importance in a group of shells of such close characters as Terebratula. These shells are usually more ventricose in the umbonal region than *T. lincklæni*, with a larger and more strongly incurved beak, the perforation of which is also larger; the front of the shell is likewise much less gibbous, often being thin and somewhat flattened below the middle, and the greatest width being above the centre instead of below, as in that species. Taking into consideration these points of dissimilarity, it may be desirable to recognize it as a distinct variety until more material may show its proper relations.

Terebratula ontario (n. s.).

PLATE LX, FIGS. 45–48.

Shell small, very broadly ovate or subcircular, with depressed convex valves of nearly equal depth; beak of the ventral valve incurved and strongly truncated by a circular perforation, the lateral margin subcarinate.

SURFACE marked only by distant concentric lines of growth.

This species resembles *T. lens* more nearly than any other in the New York rocks, but is a little more convex in proportion to its size, and the beak is comparatively higher and less incurved, while the shell is more nearly circular, and has its greatest width nearer the front.

Geological formation and locality. In the Hamilton shales on Canandaigua Lake, N. Y.

Centronella ovata (n. s.).

PLATE LXI A, FIGS. 47–49.

SHELL small, oval or slightly ovate; width and height as four to five, greatest width near the middle of the length.

DORSAL valve depressed convex, without perceptible sinus.

VENTRAL valve much deeper than the dorsal, subcarinate along the centre, most ventricose just below the beak, which is strongly incurved; lateral margins of the beak slightly carinate.

SRUFACE marked only by concentric lines of growth.

This species resembles *C. julia* in form, but is a narrower shell, with a less convex dorsal valve; the ventral valve is more ventricose and carinate along the middle, and the beak more strongly incurved.

Geological formation and locality. In the Upper Helderberg limestones at Cayuga, C. W.

Centronella julia.

PLATE LXI A, FIGS. 41–46.

Centronella julia: WINCHELL. Proc. Acad. Nat. Science, Phil. Vol. xiv., page 405. 1862.

SHELL small, lenticular.

VENTRAL valve a little more ventricose than the opposite, scarcely carinate along the middle.

DORSAL valve regularly convex, without sinus.

SURFACE unknown.

This shell closely resembles *C. ovata*, but differs in several particulars, as indicated above.

Geological formation and locality. In the Marshall sandstones, Point aux Barques, Mich.

Centronella hecate.

PLATE LXI A, FIGS. 27–29.

Centronella hecate: Billings. Canadian Journal, May, 1861, page 272.

Shell elongate, half as long again as wide, with a slightly incurved projecting ventral beak.

Dorsal valve regularly arcuate from beak to base, with a moderate mesial sinus, which is angular in the bottom.

Ventral valve sharply angular or carinate along the middle, with flattened sides.

This species resembles *C. alveata* in form, but is much smaller, the sinus is less deep and the cardinal margins not reflected while the lateral margins of the beak are rounded instead of being sharply angular.

Geological formation and locality. In the Upper Helderberg limestones at Cayuga, C. W.

Meristella lenta (n. s.).

PLATE LXIII, FIGS. 19–22.

Shell small, broadly ovate, or transversely oval, with a slightly projecting beak and very unequally convex valves.

Ventral valve nearly flat in the upper part, with sharply angular cardinal margins becoming deeply and subangularly sinuate towards the front, where it is slightly bent upwards.

Dorsal valve very ventricose in the umbonal portion, and subangular along the centre, with the sides somewhat flattened.

This species differs from any described form of the genus so far as it can be ascertained. In the form of the ventral valve it approaches somewhat the *M.* (*Pentagonia*) *unisulcata*, but the sinus is narrow instead of embracing the greater part of the valve, and it differs so materially in other respects that there is no danger of confounding the two.

Geological formation and locality. In rocks of the age of the Oriskany sandstone or Upper Helderberg limestones, near Cayuga, C. W.

Rhynchospira subglobosa.

PLATE LXIII, FIGS. 23–25.

Among the collections from the Schoharie grit, there are a few specimens of Rhynchospira which have much the general appearance of *R. globosa* of the Lower Helderberg group. They differ in having a smaller number of stronger plications, with a single, more prominent one in the middle of the dorsal valve, and a corresponding wider depression on the ventral valve; while in *R. globosa* there are one, two or three smaller plications forming a kind of mesial sinus on one or both valves, which is a constant and characteristic feature of the species, as also of all those of the Genus in the Niagara and Lower Helderberg groups.

This simple mesial plication, together with the globose form, will distinguish this from any described species of the Genus.

Remarks upon the Character of the Crura and Loop of Terebratula *and* Cryptonella *illustrated in this volume.*

A careful examination of the interior structure of the Terebratuloid shells, has shown sufficient ground for the separation of the Genus Cryptonella, and the external character of the shells would seem to afford the necessary means of distinguishing the Genera. Among the species included under the Genera Terebratula and Cryptonella, there are three distinct forms of loop which are in some degree connected with an external difference in the form of the shell.

The simplest form of loop observed is similar to that of Terebratula proper, but with the anterior extension of the crura free, or not connected by any visible extension of the calcified substance of the loop, the extremities appearing as if broken. There may have been some connexion of the parts by ligament or otherwise during the life of the animal. This form of loop, so

far as observed, is characteristic of the short ventricose shells, usually having their widest portion anterior to the middle, as in *T. jucunda*, *T. simulator*, and *T. harmonia*. Probably the New York forms of *T. rœmingeri* would show this feature could specimens be obtained suitable for cutting.

The second form of loop is short with the anterior portion sharply recurved and twisted in the curving. As examples of this form we have *T. sullivanti* in the figured specimen, and *T. rœmingeri*, from Thunder Bay, Michigan. These forms are rotund or appressed.

The third form of loop is like that of WALDHEIMIA, but has the crura connected by a band on the dorsal side opposite the crural processes. The external form of these species is more or less appressed in the upper part of the shell, with a flattened beak. The principal forms known are *Cryptonella rectirostra*, *C. planirostra*, and *C. eximia*.

The first form of loop mentioned is probably of generic importance, as there are several species which show it clearly. The second form of loop is the same as that of the third, with the exception of the dorsal band, the recurved portion being quite short. It does not, therefore, differ essentially from WALDHEIMIA except in extent. The third form differs from WALDHEIMIA only in the possession of the connecting dorsal band.

CORRIGENDA.

Page 13, line 15, after *spatulata*, insert VANUXEM.
Page 33, line 4, before beds, insert fossiliferous.
Page 36, line 7, for 1 and 2, read 1 *a* and 1 *b*.
Page 36, line 9, for 3, 4 and 5, read 2 *a–d*, 3 *a–e*.
Page 42, line 23, for **Idas** read **eryna.**
Page 45, line 20, for VI read VII.
Page 48, line 14, for LAVEILLE read LÉVEILLE.
Page 48, line 27, for VI read VII.
Page 49, line 33, for 3 *e* read 4 *e*.
Page 52, line 23, for VII read LXIII.
Page 76, line 10, before species, insert other.
Page 78, line 25, after median, insert line.
Page 101, line 4, for 1 *c* read 1 *e*.
Page 101, line 7, for 1 *l* read 1 *i*.
Page 101, line 8, for 1 *k*, *u*, read 1 *k*, *l*.
Page 101, line 10, for 15 read 13.
Page 108, line 21, for **textilis** read **Junia.**
Page 109, line 32, *dele* this line.
Page 111, line 10, for XIX A. read XV.
Page 111, line 11, for *Strophodonta* read *Strophomena.*
Page 112, line 9, for *elmira* read *cayuta.*
Page 113, line 9, for 8 read 6.
Page 116, line 7, for no species read one species.
Page 136, lines 4 and 5, *dele* reference to Plate 22.
Page 136, line 19, for *koninckii* read *koninckiana.*
Page 137, line 19, refer species to PLATE XXII.
Page 138, line 12, after forty insert (including bifurcations.)
Page 143, line 1, for **muricatus** read **muricata.**
Page 144, line 19, for (fig. 00) read (fig. 33).
Page 156, line 1, refer species to PLATE XXIII.
Page 165, line 23, for **Productus?** read **Productus (Productella) papulata** (n. s.).
Page 166, line 4, insert beneath, *Productus hirsutus*: HALL, 10th Rep. St. Cab. p. 175. 1857.
Page 167, line 21, for 1-9 read 18-27.
Page 167, line 29, for 9 read 21.
Page 171, line 15, for 19-23 read 1-9.
Page 183, line 29, for or two, read one, two.
Page 188, lines 1 and 3, for CYRTÆNA read CYRTINA.
Page 189, line 2, for **Spirifer** read **Spirifera.**
Page 196, line 12, for species read shells.
Page 200, line 23, for 34 read 35.
Page 201, line 3, for 34 read 35.
Page 205, line 21, for XXX read XXXI
Page 207, line 30, after of the, insert area.
Page 218, line 21, for 33 read 34.
Page 223, line 22, for *S. arcta* read *S. arata.*
Page 225, line 17, *dele* sentence referring to casts.
Page 229, line 5, for XXXVIII read XXXVIII *.
Page 234, line 18, for XXXII read XXXIII.
Page 241, line 11, for greasly read greatly.
Page 246, lines 10 and 17, for XLI read XLII.
Page 246, line 12, for 15 read 17.
Page 246, lines 18 and 33, for XLII read XLI.
Page 250, line 2, for XXXII read XXXIII.
Page 251, line 13, for XXXII read XXXIII.
Page 251, line 15, for 32 read 31.
Page 251, line 18, *dele* 2d comma, and insert variation.
Page 253, line 32, for *marylandica* read *cumberlandia.*
Page 262, line 27, for 5 *a* read 5.
Page 270, line 3, for XVII read XLIV.
Page 271, lines 9 and 10, *dele* reference to dotted line.
Page 279, line 33, for XIV read XLV.
Page 287, line 9, for 10 read 8.
Page 287, line 10, for 8 read 9.
Page 287, line 11, for 9 read 10.
Page 290, line 13, after *h* insert (see figure on Explanation of Plate.)
Page 299, line 18, change reference of *A. nasuta* to Jour. Acad. Nat. Sci. Ph. vol. viii, p. 265. 1842.
Page 305, line 33, for shade read shale.
Page 329, line 2, for LIII read LII.
Page 329, line 10, *dele* mny—may.
Page 343, line 2, for LIV read LIV A.
Page 344, lines 2 and 25, for LIV read LIV A.
Page 346, line 2, for LV read LIV A.
Page 349, line 1, after **stephani** add (n. a.).
Page 357, line 1, after **mysia** add (n. a.).
Page 361, line 2, for LVI read LVII.
Page 364, line 16, for LVII read LVI.
Page 373, line 37, *dele P. obsolescens.*
Page 380, line 6, for LVIII read LVIII A.
Page 384, line 28, for LIX read LVIII A.
Page 385, line 7, for LX read LVIII A.
Page 388, line 5, *dele* without appendage.
Page 397, line 1, for **Cryptonella ?** read **Terebratula.**
Page 399, line 17, for LXI read LXI A.
Page 401, line 2, for LXI read LXI A.
Page 402, line 2, for LXI read LXI A.
Page 403, line 10, for LXI read LXI A.
Page 408, line 33, for LXII read LXI A.
Page 412, line 3, after PLATE add LXIII.

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EXPLANATIONS AND PLATES.

EXPLANATION OF FIGURES.—PLATE 1.

Page

Fig. 1. LINGULA SPATULATA..... 13

1 *a*. A specimen of the natural size.
1 *b*. An enlargement of the specimen 1 *a*.

Fig. 2. LINGULA LIGEA..... 7

2 *a*. The exterior of a valve, natural size.
2 *b*. The interior of a valve which shows faint indication of muscular or vascular marking about the middle of its length.

Figs. 3, 4. LINGULA MELIE..... 14

3, 4. Show the extremes of form among a considerable number of specimens.

Fig. 5. LINGULA CUYAHOGA..... 15

5. A single valve of the natural size.

Fig. 6. LINGULA PUNCTATA..... 10

6 *a*. A young individual of the natural size.
6 *b*. An individual of the ordinary size, which is a little wider than usual.
6 *c*. The interior of a valve.
6 *d*. An individual from which the shell is nearly all exfoliated, showing the peculiar muscular impressions illustrated in fig. 6 *e*, which is enlarged two diameters. It is probably the ventral valve.
6 *f*. Another individual which shows the muscular impressions of a little different form, with a longitudinal depression. It is probably the dorsal valve.
6 *g*. Is an enlargement of the surface showing the texture of the shell.
Shells having these interior characters should properly be separated from *Lingula*.

Fig. 7. LINGULA PALÆFORMIS..... 8

7. A specimen (probably the ventral valve), natural size.

Figs. 8, 9. LINGULA EXILIS..... 7

8. A specimen, natural size, with the beak imperfect.
9. A more convex individual which may belong to this species.

Figs. 10, 11. DISCINA NEWBERRYI..... 25

10 *a*. A dorsal valve of this species.
10 *b*. A ventral valve with the shell nearly all exfoliated.
11 *a*. A dorsal valve of this species.
11 *b*. A profile of the same.
11 *c*. A dorsal valve of different form, but probably of the same species.

Figs. 12, 13. DISCINA NEGLECTA..... 24

12. An impression of the dorsal valve with a part of the shell remaining in the centre, and showing the muscular impressions.
13. From a gutta-percha cast made in the impression of a dorsal valve.

HAMILTON AND CHEMUNG GROUPS.

(BRACHIOPODA.)

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PLATE 1—Continued.

Page.

Fig. 14. DISCINA LODENSIS..... 22

14 *a*, *b*, *c*, *e*. Varieties of form of the dorsal valve.
14 *d*, *f*. Ventral valves of the same species.

Fig. 15. DISCINA TRUNCATA..... 23

15 *a*. A dorsal valve of the natural size.
15 *b*. The same enlarged.

Fig. 16. DISCINA MINUTA..... 16

16 *a*. A dorsal valve of the natural size.
16 *b*. The same enlarged.

Fig. 17. DISCINA ALLEGHANIA..... 25

17 *a*. The dorsal valve of a large individual.
17 *b*. A profile view of fig. 17 *a*.
17 *c*. The ventral valve of the same species.

Fig. 18. DISCINA GRANDIS..... 17

18 *a*. A dorsal valve which is somewhat distorted.
18 *b*. The interior of a ventral valve of the same species.

PLATE 2.

Page

Fig. 1. LINGULA CERYX..... 5

1. An imperfect valve in arenaceous rock.

Fig. 2. LINGULA DESIDERATA..... 6

2 An imperfect valve enlarged to two diameters.

Fig. 3. LINGULA MANNI..... 6

3. A single valve of natural size.

Figs. 4 – 6. LINGULA NUDA..... 10

4, 5, 6. Separate valves presenting the usual variety of form of this species.

Fig. 7. LINGULA PUNCTATA..... 10

7. Profile of a specimen retaining both valves in connexion.

Fig. 8. LINGULA LIGEA var..... 8

8. A specimen of this species from the Portage group, at Trumansburgh, N. Y.

Fig. 9. LINGULA DELIA..... 12

9. A specimen of the natural size, showing the mark of a linear septum.

Figs. 10, 11. LINGULA DENSA..... 11

10, 11. A ventral and dorsal valve of the natural size.

Fig. 12. LINGULA LEANA..... 9

12. A ventral valve of the natural size.

Fig. 13. LINGULA MAIDA..... 9

13. A specimen of the natural size.

Figs. 14, 15. LINGULA ALVEATA..... 12

14. An impression with the remains of the shell on the margin, showing the mark of a longitudinal septum.

15. A larger individual; the impression in shale shows what appears to have been a triple medial septum.

Figs. 16, 17. DISCINA TULLIA..... 22

16. Vertical view of a dorsal valve, natural size.

17. Profile of the same.

Fig. 18. DISCINA HUMILIS..... 16

18. View of a ventral valve.

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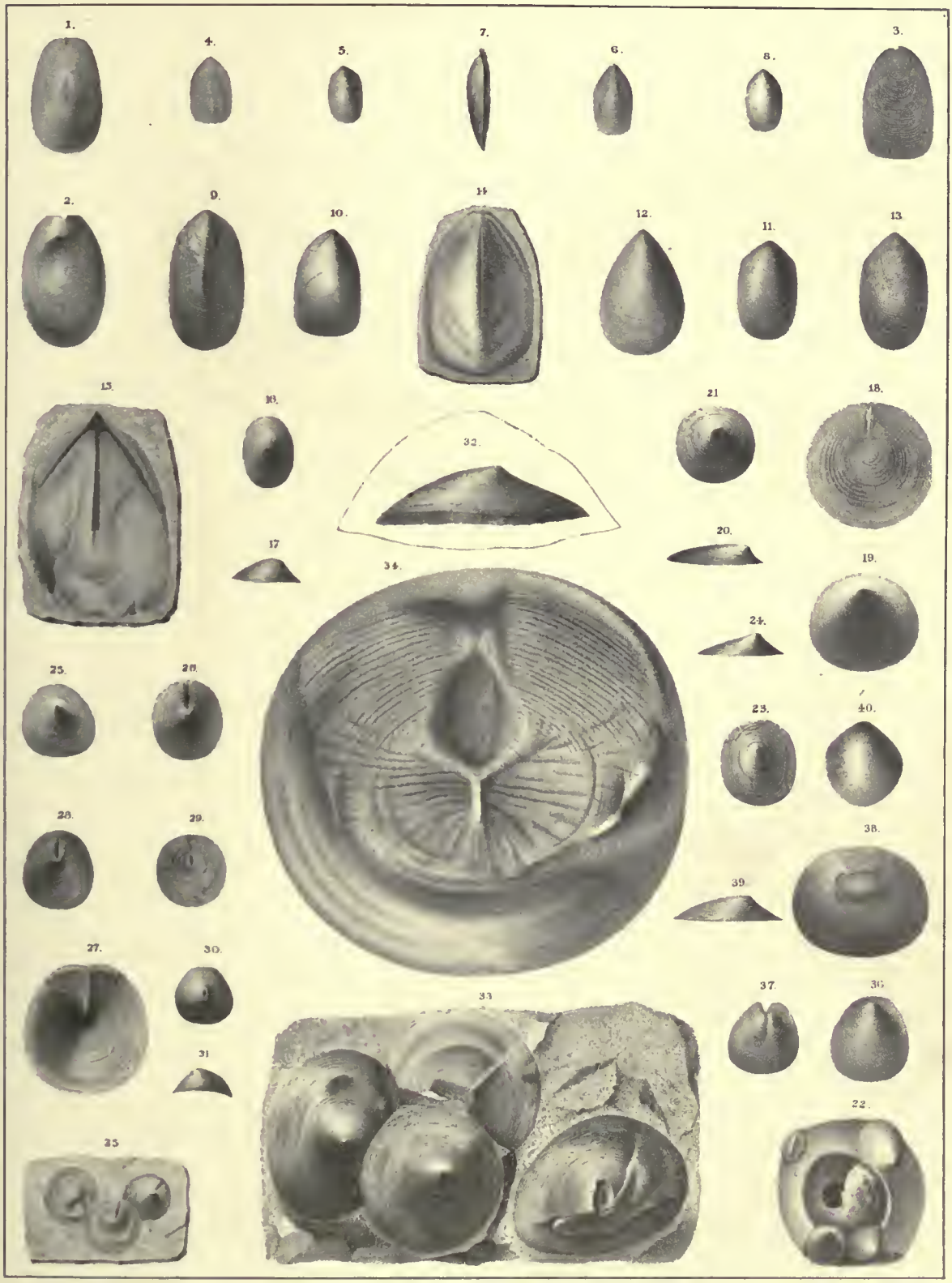

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PLATE 2—Continued.

Page

Figs. 19–22. DISCINA DORIA 19

19. Vertical view of a specimen of an upper valve; enlarged two diameters.
20. Profile of the same, from Canada West.
21. A dorsal valve of the same species, natural size.
22. A group of specimens attached to a univalve shell.

Figs. 23, 24. DISCINA SENECA 20

23. Vertical view of a dorsal valve, natural size.
24. Profile of the same.

Figs. 25–28. DISCINA MEDIA 20

25, 26. Dorsal and ventral valves, natural size.
27. A ventral valve enlarged two diameters.
28. A specimen of the ventral valve of this species, from the Chemung group.

Fig. 29. DISCINA MEDIA var 21

29. A ventral valve from the Marcellus shale.

Figs. 30, 31. DISCINA DORIA. ? 21

30. A vertical view of a dorsal valve, which is rather more convex than usual in this species.
31. A profile of the same.

Figs. 32, 33. DISCINA GRANDIS 17

32. A profile showing the usual elevation. The line surrounding this figure gives the elevation of a specimen referred to this species, Plate 1, fig. 18 *a*.
33. A fragment of rock with a group of four individuals of this species.

Fig. 34. DISCINA RANDALLI 18

34. The lower side of a ventral valve, natural size.

Fig. 35. DISCINA LODENSIS 22

35. A group of three ventral valves, natural size.

Figs. 36, 37. DISCINA TRUNCATA 23

36, 37. Dorsal and ventral valves enlarged to three diameters.

Figs. 38, 39. DISCINA ELMIRA 24

38. A dorsal valve, vertical view.
39. Profile of the same.
40. Undetermined.

PLATE 3.

Page

Figs. 1, 2. PHOLIDOPS OVALIS.

1, 2. Vertical and profile views of a specimen retaining both valves. From the Niagara group of Waldron, Ind. Enlarged to five diameters.

Fig. 3. PHOLIDOPS ARENARIA..... (See note on 32)

A cast of the valve from the Oriskany sandstone, enlarged to three diameters. See p. 413.

Figs. 4, 5. PHOLIDOPS AREOLATA..... 31

4. An impression of the dorsal valve.
5. An impression of the ventral valve. The figures enlarged to three diameters.

Figs. 6–9. PHOLIDOPS HAMILTONIÆ..... 32

6. The exterior of the shell, enlarged to four diameters.
7. The interior of ventral valve, showing the muscular impressions.
8. An impression of the ventral valve.
9. The opposite or dorsal valve of the same species, enlarged to eight diameters.

Fig. 10. PHOLIDOPS OBLATA..... 413

10. An impression (apparently of the dorsal valve), showing the muscular impression; enlarged to four diameters.

Fig. 11. PHOLIDOPS ? LAMELLOSA..... 413

11. Ventral ? valve of the specimen; enlarged to two diameters.

Fig. 12. CRANIA AURORA..... 27

12. An impression of a ventral valve.

Figs. 13–16. CRANIA CRENISTRIATA..... 28

13. The dorsal valve of a small individual.
14. The dorsal valve of a large individual, the margins having been crushed.
15. Vertical view of a broadly elliptical dorsal valve.
16. Profile of the same.

Figs. 17–23. CRANIA HAMILTONIÆ..... 27

17. Vertical view of a dorsal valve.
18. Profile of the above.
19. Two individuals attached to the surface of a shell of *Tropidoleptus*, one of them having carried the form of the ribs of the shell into its growth.
20. The interior of a ventral valve.
21. A group of ventral valves attached to the surface of *Microdon bellastriata*.
22. A ventral valve having the cardinal border modified in its outline by the presence of *Spirorbis angulata a*, *a*, attached to the same shell surface with the *Crania*.
23. An enlargement of the specimen fig. 22, intended to show the muscular and vascular markings more distinctly.

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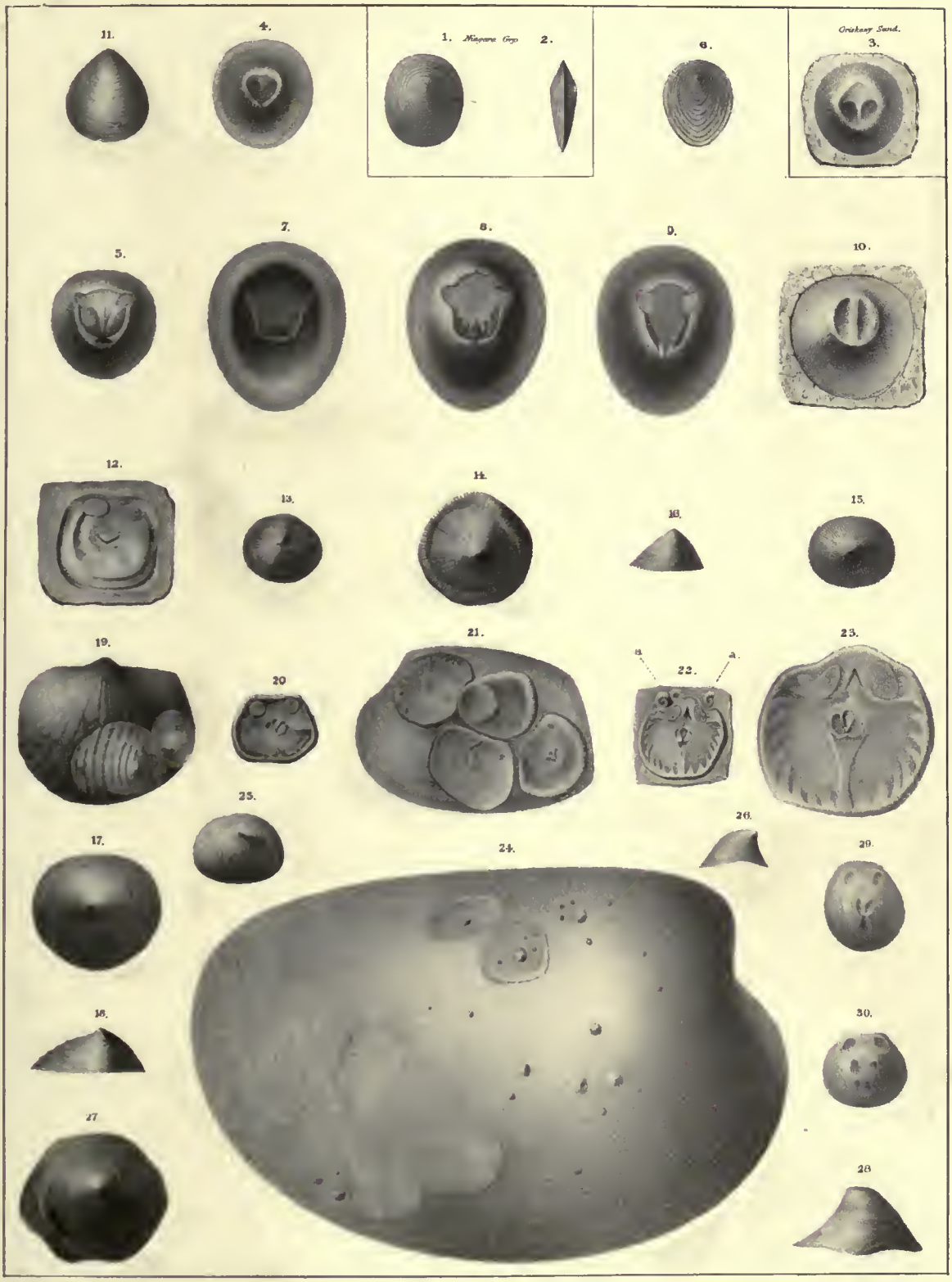

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PLATE 3—Continued.

Page.

Fig. 24. CRANIA GREGARIA..... 29

24. A large bivalve shell with numerous individuals of the *Crania* attached to its surface. There are also the remains of the ventral valves of *C. hamiltoniæ*, and the smaller ones are perhaps only the young of that species.

Figs. 25, 26. CRANIA LEGNI?..... 30

25. The dorsal valve of this species.
26. A profile of the same.

Figs. 27–30. CRANIA LEONI..... 30

27. Dorsal valve retaining the shell, supposed to be of this species.
28. Profile of the same.
29. The cast of a dorsal ? valve of this species.
30. The cast of a ventral ? valve of the same.

PLATE 4.

Page

Figs. 1, 8, 9, 10. ORTHIS PELORIS..... 34

1. The ventral valve from a gutta-percha cast of an impression in the stone.
8, 9. Natural casts of the ventral valve.
10. A natural cast of the dorsal valve.

Figs. 2–7. ORTHIS ALSUS..... 36

2. The dorsal valve of this species ? from a gutta-percha cast of an impression of the exterior.
3. The exterior of a dorsal valve, showing a mesial depression.
4. A cast of the interior of a ventral valve.
5. A cast of the interior of a dorsal valve.
6. A cast of a ventral valve which is nearly flat.
7. A cast of a dorsal valve, the muscular impressions being scarcely defined.

Figs. 11–19. STREPTORHYNCHUS CHEMUNGENSIS, var. PANDORA..... 68

11. A cast of the dorsal valve of a young individual.
12. A gutta-percha cast of an impression of the exterior of a ventral valve.
13. A cast in stone, of the dorsal valve.
14. A gutta-percha impression from a cast of the dorsal valve.
15. A cast of the dorsal valve retaining the shell on the margins.
16. The cast of a small dorsal valve.
17. The interior of a ventral valve, from a gutta-percha impression.
18. The cast of a ventral valve.
19 A ventral valve which is more finely striate than is usual with this species; probably an extreme variety.

Schoharie Grit.

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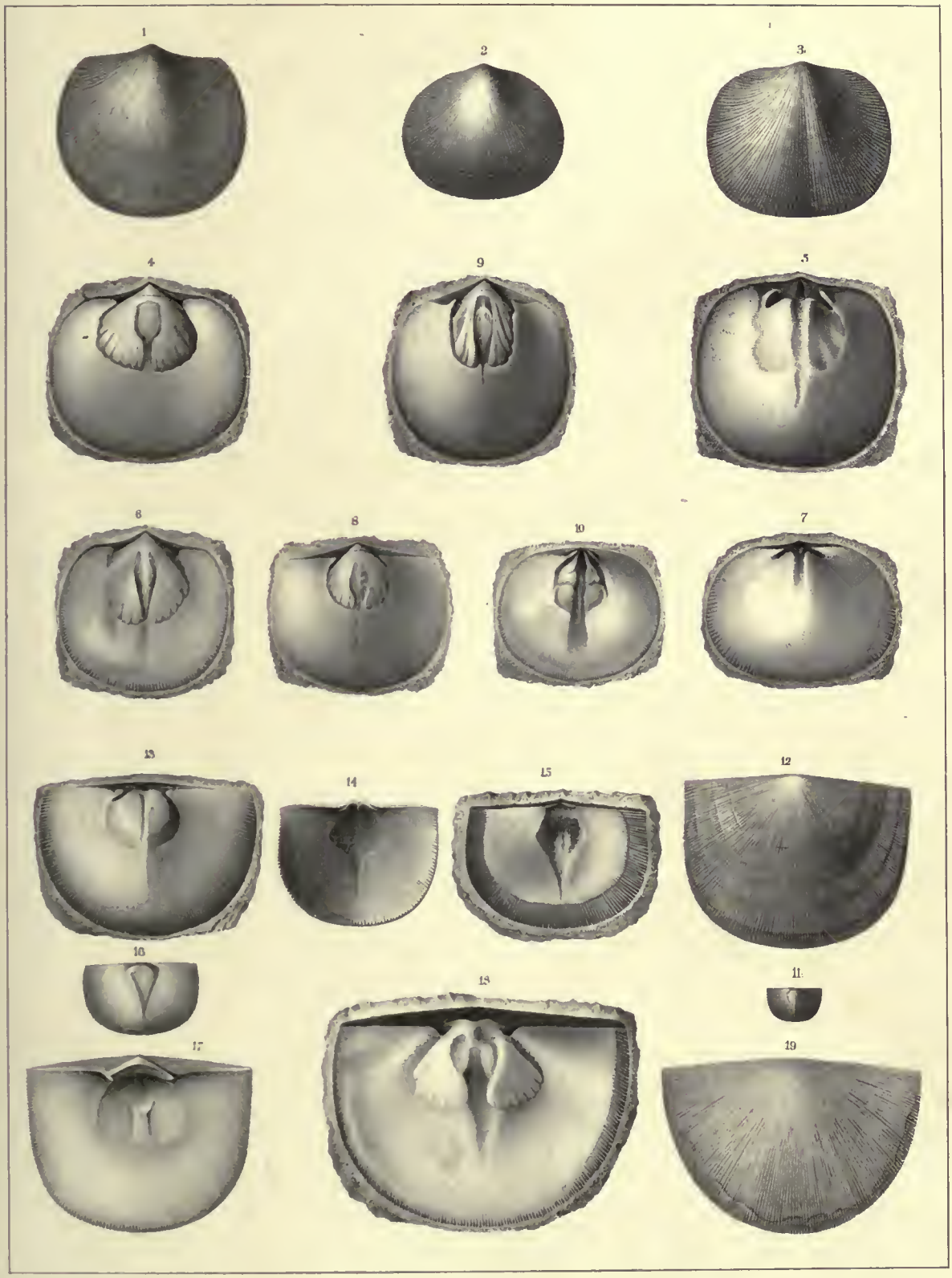

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PLATE 5.

Page

Figs. 1, 2. ORTHIS LENTICULARIS 35

1 *a*, *b*. Dorsal and ventral views.
1 *c*. Profile of the above.
1 *d*, *e*. Cardinal and front views of the same shell.
2 *a*, *b*. Dorsal and ventral views of a larger shell.
2 *c*, *d*. Profile, and front view of the same.
2 *e*. Interior of a ventral valve.

Fig. 3. ORTHIS PROPINQUA..... 43

3 *a*, *b*. Ventral and dorsal views of a small gibbous specimen, from cherty layers of Corniferous limestone at Lapham's mill, Ontario county.
3 *c*. Profile of the above.
3 *d*, *e*. Ventral, and dorsal views of a large individual, from near Columbus, Ohio.
3 *f*. Profile of the above.
3 *g*. A cast of the dorsal valve, showing muscular and vascular impressions; from Avon, N. Y.

Fig. 4. ORTHIS LIVIA..... 38

4 *a*. *b*. Dorsal and ventral views of a specimen from the Corniferous limestone of Western New York.
4 *c*. Profile of the above.

Fig. 5. ORTHIS SP.?..... 39

5 *a*, *b*. Dorsal and ventral views of a specimen.

Fig. 6. ORTHIS VANUXEMI ?..... 40

6 *a*, *b*. The exterior and interior of a ventral valve.

Fig. 7. ORTHIS SEMELE..... 40

7. The exterior of a ventral valve, showing the extent of the hinge-line.
8. The interior of a ventral valve. The specimen occurs in the same stone with fig. 7, but the hinge-line is imperfect and does not appear to have been so much extended as in that specimen.

Figs. 9, 10. ORTHIS CLEOBIS. 41

9. A cast of the dorsal valve, showing the impression of the area.
10. A cast of the ventral valve.

Fig. 11. ORTHIS IDAS..... 42

11 *a*, *b*. Dorsal and ventral views of the same specimen. *O. eryna*, see Errata.

UPPER HELDERBERG GROUP.

Corniferous Limestone.

(BRACHIOPODA.)

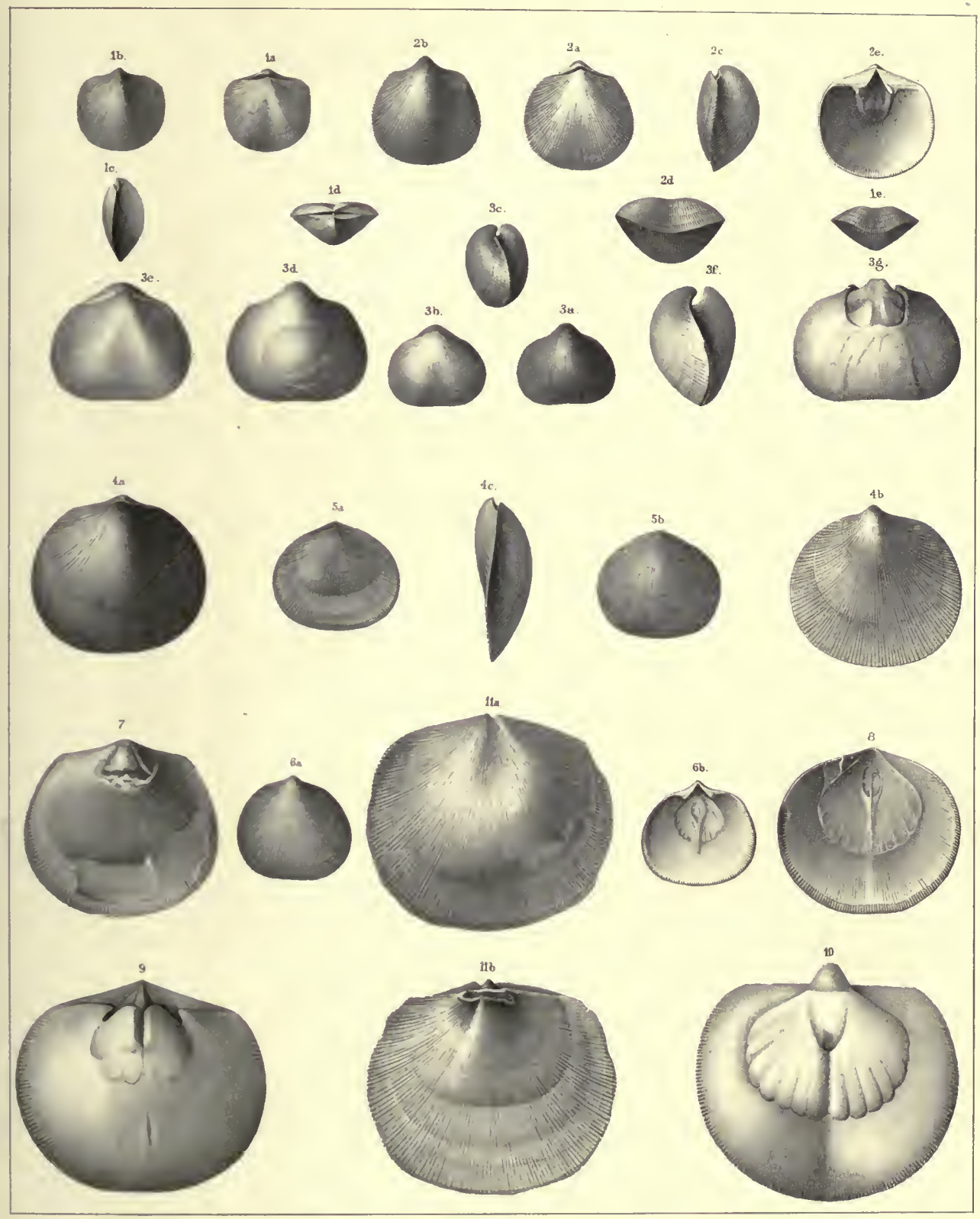

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PLATE 6.

Page

Fig. 1. ORTHIS LEPIDUS..... 46

1 *a*. Ventral view of a specimen, natural size.
1 *b*. Dorsal view, natural size.
1 *c*, *d*. Ventral and dorsal views, enlarged to two and a half diameters.
1 *e*, *f*. Profile, and front views, same enlargement.

Fig. 2. ORTHIS PENELOPE..... 50

2 *a*. Dorsal view of a young individual.
2 *b*. A ventral view of an older individual.
2 *c*. A dorsal view of a specimen of the ordinary size.
2 *d*. Dorsal view of a large Individual.
2 *e*. Profile of the above.
2 *f*. Cardinal view of the same.
2 *g*, *h*. The interiors of ventral valves, showing the form of the muscular impression.
2 *i*. The same, with the shell much thickened around the muscular impression and towards the front.
2 *k* The interior of a dorsal valve, showing a thickening of the cardinal process.
2 *l*. An enlargement of the surface, showing the character of the striæ, the ordinary puncta, and the elongate tubular openings.
2 *m*. A cast of the dorsal valve of the same species, from Cumberland, Md.

Fig. 3. ORTHIS VANUXEMI..... 47

3 *a*, *b*, Ventral and dorsal views of a young individual.
3 *c*. Ventral view of a specimen of medium size, presenting the ordinary form of the species.
3 *d*. A ventral view of another individual.
3 *e*. Profile of a specimen.
3 *f*. A ventral view.
3 *g*. Dorsal view.
3 *h*. Ventral view of a large Individual—the largest which can be satisfactorily referred to this species.
3 *i*. Dorsal view of the above.
3 *k*. Profile of the same.
3 *l*. Cardinal view of the same.
3 *m*. The interior of a ventral valve.
3 *n*, *o*. The interiors of dorsal valves.
3 *p*. An enlargement of the surface striæ, showing the puncta and tubular openings enlarged to the same degree as fig. 2 *l*, offering a comparison of the character of striæ mode of bifurcations, tubular openings, etc.
3 *r*. A cast of a ventral valve supposed to be of this species, from Cumberland, Md.

(BRACHIOPODA.)

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Swinton. Lith Murray. Imp

PLATE 7.

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Fig. 1. ORTHIS SOLITARIA..... 45

1 *a*. Dorsal view of the specimen described.
1 *b*. Ventral view of the same.
1 *c*. Profile of the same.
1 *d*. Front view of the same.

Figs. 2, 3. ORTHIS CYCLAS..... 52

2 *a*. Dorsal view of a specimen enlarged to two diameters.
2 *b*. Ventral view of the same.
3. A ventral valve enlarged to two diameters.

Fig. 4. ORTHIS LEUCOSIA..... 48

4 *a*. Ventral view of a small specimen.
4 *b*. Dorsal view of the same.
4 *c*. Dorsal view of a specimen of ordinary size. Larger specimens have been obtained since these figures were made.
4 *d*. Ventral view of the same.
4 *e*. Profile of the same.
4 *f*. Cardinal view of the same.
4 *g*. The interior of a dorsal valve.
4 *h*. The interior of a ventral valve.
4 *i*. A cast of a ventral valve which is probably of this species, from Cumberland, Md.

Fig. 5. ORTHIS TULLIENSIS..... 55

5 *a*. Dorsal view of a specimen of ordinary size.
5 *b*. Ventral view of the same.
5 *c*. Profile of the same.
5 *d*. Cardinal view of the same.
5 *e*. Front view of the same.
5 *f*. Ventral view of a more gibbous specimen.
5 *g*. Profile of the same.
5 *h*. Front view of the same.
5 *i*. Dorsal view of a cast of this species.
5 *k*. Ventral view of the same.

HAMILTON GROUP.

(BRACHIOPODA.)

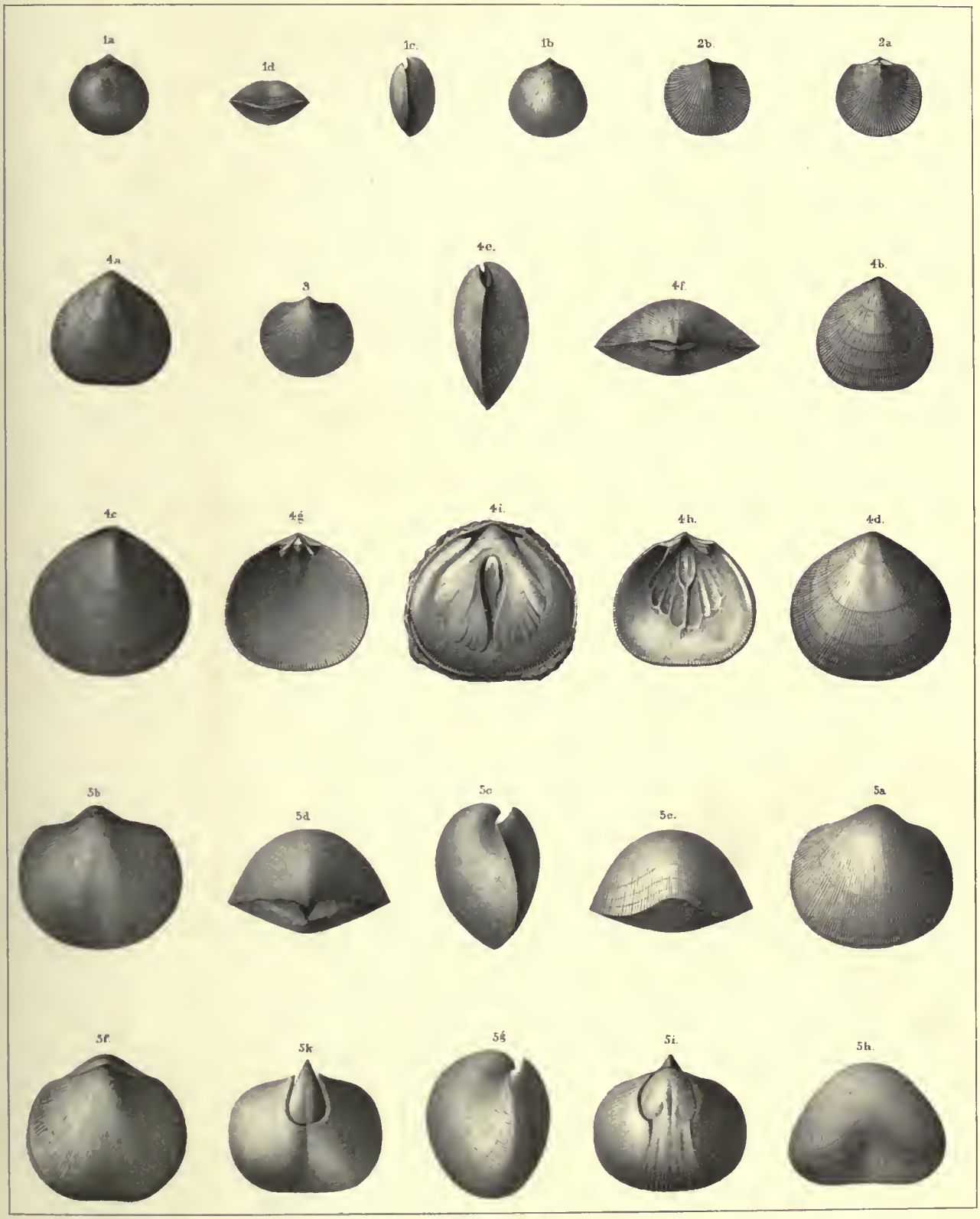

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PLATE 8.

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Fig. 1. ORTHIS LEONENSIS?..... 62

1. Cast of ventral valve.

Fig. 2. ORTHIS THIEMEI.?..... 63

2 Cast of the ventral valve.

Figs. 3–8. ORTHIS LEONENSIS..... 62

3. A dorsal valve.
4, 5. Casts of dorsal valves.
6, 7. Casts of ventral valves.
8. Exterior of a ventral valve.

Figs. 9, 10. ORTHIS LEUCOSIA?..... 63

9, 10. The exterior of a dorsal valve and cast of the ventral valve.

Figs. 11–19. ORTHIS IMPRESSA..... 60

11, 12. Casts of ventral valves of young individuals.
13. A dorsal valve retaining the shell.
14. Cast of a dorsal valve, showing muscular impressions and vascular lines.
15. Ventral valve retaining the shell.
16–18. Casts of ventral valves of the usual forms.
19. A cast of an unusually large specimen of a ventral valve.

Figs. 20–29. ORTHIS TIOGA..... 59

20–23. Illustrations of the dorsal valve.
24, 25. Casts of the dorsal valve retaining impressions of the surface striæ.
26, 27. Ventral valves showing the mesial elevation.
28, 29. Casts of the ventral valve, showing muscular impressions.

Figs. 30–32. ORTHIS CARINATA..... 58

30. Cast of a ventral valve of this species.
31. A dorsal valve with the shell partly exfoliated.
32. A cast of the dorsal valve showing the form of the muscular impression.

CHEMUNG GROUP.

(BRACHIOPODA.)

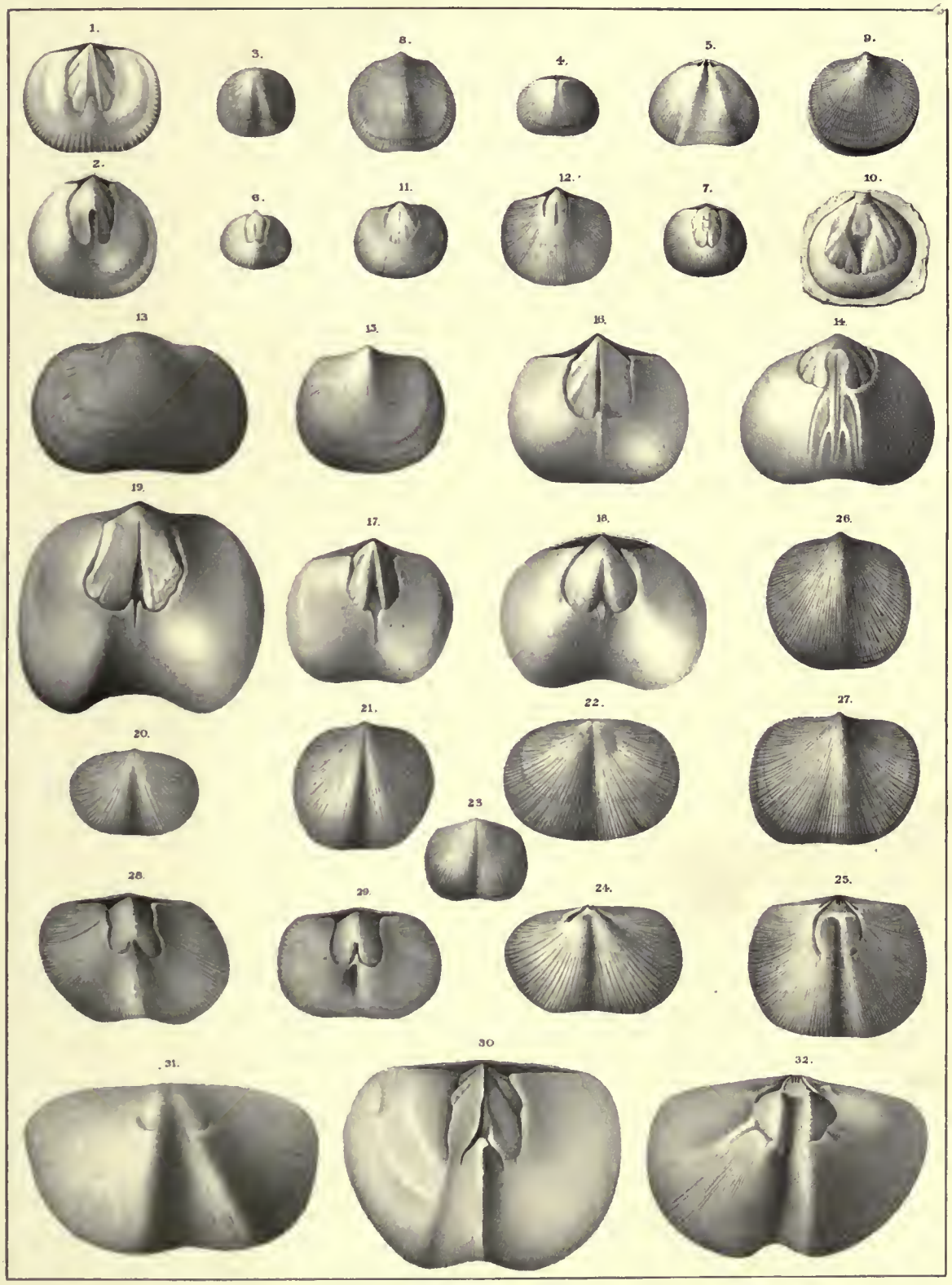

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PLATE 9.

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Figs. 1 – 12. STREPTORHYNCHUS CHEMUNGENSIS var. ARCTOSTRIATA..... 71

1, 2. Ventral valves of young specimens where the beaks are somewhat distorted, and the striæ not alternating in strength.

3, 4. External and internal views of a dorsal valve of similar character.

5. Interior of a dorsal valve, the striæ of which are sharp and equal in size.

6, 7. Exterior and interior of a larger dorsal valve, the striæ of which are distinctly alternating in strength.

8, 9. Ventral and dorsal valves of a semicircular form, where the striæ are sharp and of equal strength. Original of *Orthisina* [*S.*] *arctostriata*, 13th Report on State Cabinet.

10. Cardinal view of specimen, fig. 2, showing the distortion of the beak and the covered foramen; enlarged to two diameters.

11. Interior of a ventral valve of a specimen having equal striæ; showing muscular impression, teeth and covered deltidium.

12. Enlarged view of a cast of a specimen having sharp equal striæ, and showing the imprint of the adductor and retractor muscles very well preserved.

12. † Enlargement of surface striæ, showing their alternating character.

Figs. 13 – 17, 26. STREPTORHYNCHUS CHEMUNGENSIS var. PERVERSA... 72

13, 14. Dorsal valves of specimens, showing the alternating character of the striæ.

15. View of an imperfect ventral valve.

16. Ventral valve of an individual retaining but a portion of the shell.

17. Cast of a large dorsal valve showing the impression of the alternating striæ.

26. View of a very convex, finely striated dorsal valve; referred with doubt to *S. perversa*.

Figs. 18 – 25, 27. STREPTORHYNCHUS CHEMUNGENSIS var. PANDORA..... 68

18, 19, 20. Dorsal and ventral views and profile of a very symmetrical specimen of the species.

21. Interior of a dorsal valve, showing the muscular impressions, cardinal process and socket plates.

23. Interior of a ventral valve, showing muscular impressions, cardinal area and teeth.

24, 25. Casts of a dorsal and ventral valve, showing the characters of the muscular impressions.

27. Exterior of a large ventral valve.

(BRACHIOPODA)

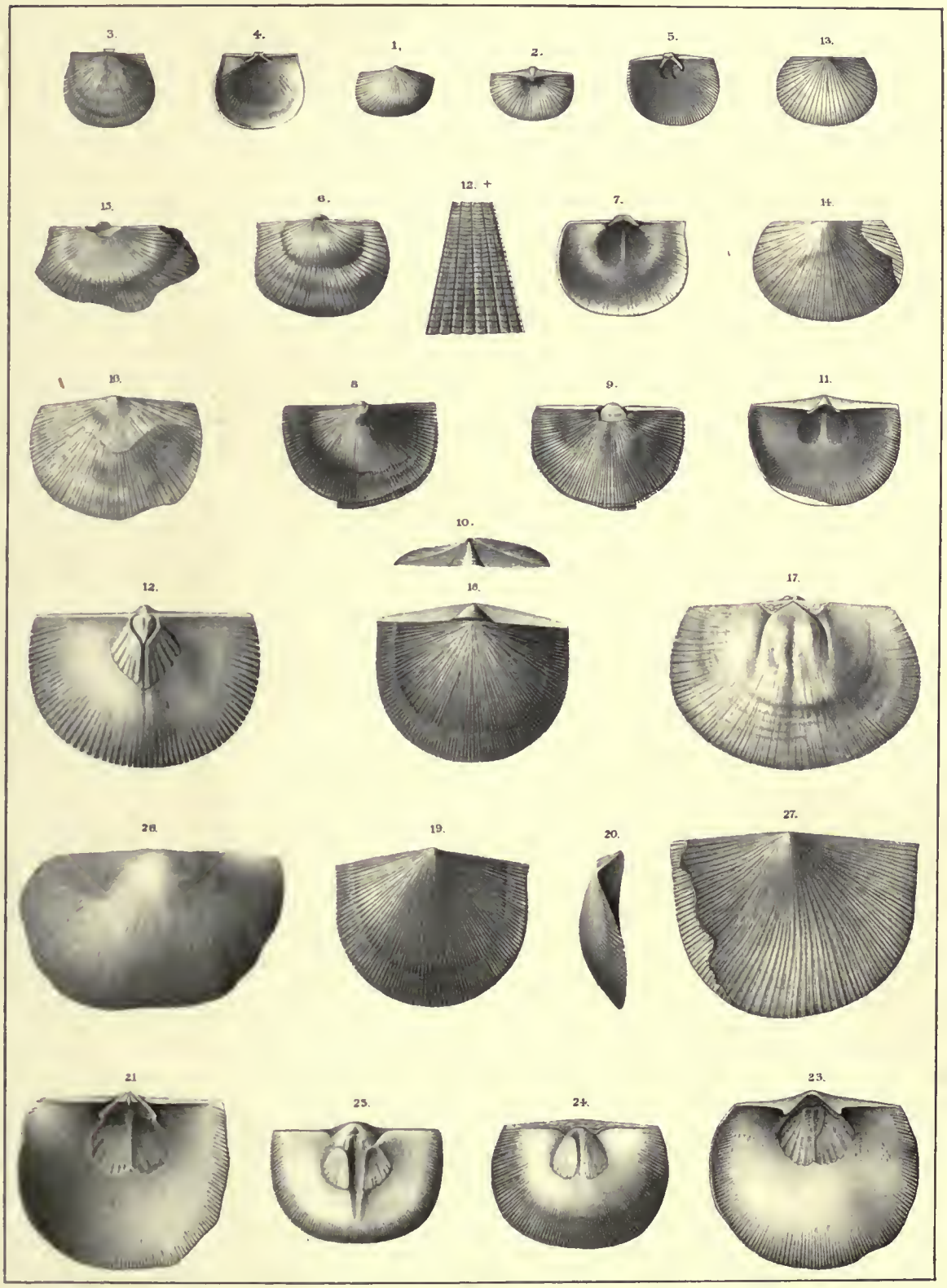

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PLATE 10.

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Figs. 1 – 26. STREPTORHYNCHUS CHEMUNGENSIS..... 67

1. A dorsal valve of symmetrical proportions, which has a convexity a little greater than that of the ordinary specimens of *S. pandora* in the Corniferous limestone. The striæ are bifurcate, and in their partially preserved condition, are unequal at the margin of the shell; a few finer ones between the larger reaching half or two-thirds the way to the apex.
2. The exterior of a ventral valve which is nearly flat, being slightly concave below the middle; the apex is prominent and very slightly unsymmetrical.
3. A cast of the same valve showing the muscular impression.
4. The exterior of a dorsal valve which is regularly convex; the striæ are sharply elevated and fasciculate, there being two or three finer ones between the stronger and more elevated ones.
5. A cast of the interior of the same valve showing the muscular and vascular impressions.
6. A dorsal valve of moderate convexity with one of the cardinal extremities abruptly rounded, and the other distorted, apparently from some accidental cause. The striæ are fasciculate, there being one, two or three finer ones between the stronger sharply elevated ones on the lower half of the valve, while towards the beak they are all sub-equal. This is the original of *Strophomena pectinacea*.

6 *a*. An enlargement of striæ, from specimen fig. 6, *S. pectinacea*.

7. A convex dorsal valve with the cardinal extremities slightly rounded; the striæ are, in some parts, sub-equal, and in others alternating in size, and the stronger ones are sometimes interruptedly depressed. The mesial portion of the valve is flattened The specimen shows the striæ curving upward to the hinge line in a most remarkable degree.
8. The cast of a large and very convex dorsal valve with the extremities abruptly rounded. The surface is unequally striated. The umbo is large and very prominent, while the surface below the umbo to the front is somewhat depressed convex, and abruptly depressed on each side, leaving the space between that part and the hinge extremities concave. This specimen may be compared with fig. 26, Plate 9, from the Corniferous limestone.
9. A cardinal view of fig. 8.
10. A slightly concave ventral valve where the striæ are sub-equal and bifurcating, or increasing by interstitial additions. The character of striæ is precisely similar to those of the Corniferous limestone specimens of *S. pandora*.
11. A dorsal view in which the striæ are sharp and sub-equal; of the type of *Strophomena arctostriata*.
12. A specimen of similar character which is extremely unsymmetrical.

12 *a*. An enlargement of the striæ which characterize the specimens like those from 11 to 17.

13. A ventral view of an unsymmetrical specimen.
14. A cardinal view of the preceding specimen.
15. A profile of the same.
16. A cardinal view of specimen when the apex is less extended.
17. A profile of fig. 16. The specimens 11 to 17, are of the type of *Strophomena arctostriata*, showing various degrees of distortion.
18. A ventral valve with rather deep and coarse striæ.
19, 20. Casts of dorsal valves of nearly symmetrical forms.
21, 22. Casts of ventral valves.
23. A cardinal view of a cast of a large ventral valve which is symmetrical on the hinge line.
24. The cardinal process from a gutta-percha cast from specimen fig. 9.

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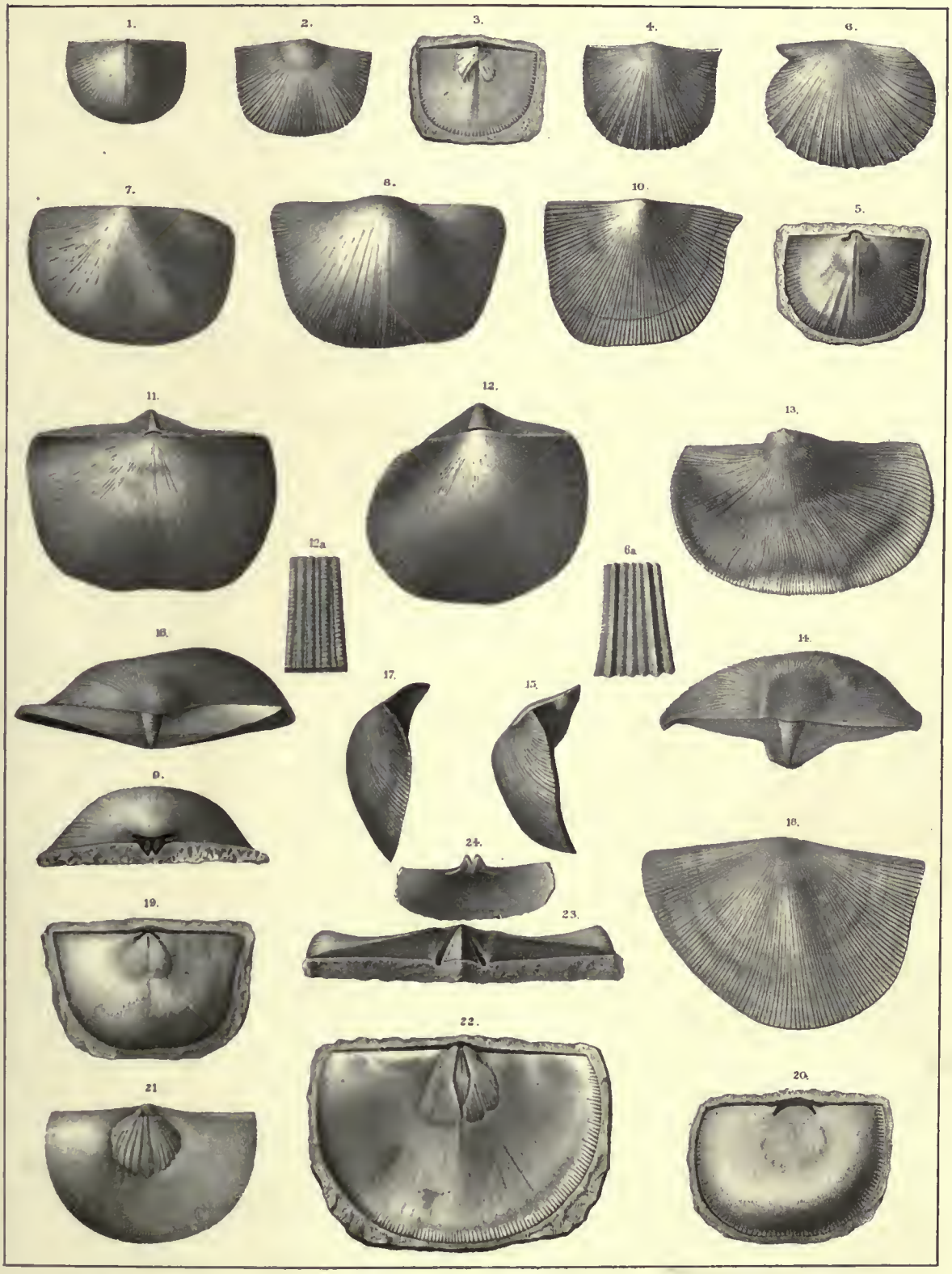

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PLATE 11.

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Figs. 1 – 3. STROPHODONTA ALVEATA..... 81

1. The interior of a dorsal valve as obtained from a cast in the Schoharie grit.
2. The cast of a ventral valve.
3. A smaller ventral valve of the same species.

Figs. 4 – 10. STROPHODONTA CALLOSA..... 82

4. Interior of a dorsal valve, from an impression in the natural mould, showing muscular impressions and cardinal process; enlarged to two diameters.
6, 7. Casts of ventral valves, natural size.
8. Interior of the dorsal valve, from an impression in the natural mould, showing muscular impressions, cardinal process, and the crenulated hinge line; enlarged to two diameters.
9, 10. Cardinal and ventral views of a cast of a ventral valve, showing the muscular impressions very distinctly; enlarged to two diameters.

Figs. 5, 11. STROPHODONTA PARVA..... 85

5. Impression of a dorsal valve of this species.
11. Cast of a ventral valve, enlarged to two diameters, showing muscular impressions and the crenulated hinge.

Figs. 12, 13, 18 – 21. STROPHODONTA CREBRISTRIATA..... 86

12. Exterior of a small ventral valve.
13. Exterior of a smaller ventral valve, enlarged to two diameters.
18, 19. Exterior and profile of a larger ventral valve.
20. Enlargement of the surface striæ.
21. Exterior of a very large ventral valve.
23. Interior of a dorsal valve, from an impression in the natural mould. Doubtfully referred to this species.

Figs. 14 – 17. STROPHODONTA DEMISSA..... 81

14. View of a ventral valve taken from an impression left in the Schoharie grit by the decay of the shell.
15. Internal cast of a ventral valve in the grit.
16. Interior of a dorsal valve, showing the muscular impressions and cardinal process.
17. Cast of the interior of a ventral valve, showing the muscular impressions in a very perfect manner. From the soft shales of the Hamilton group.

Fig. 22. STROPHODONTA PERPLANA..... 92

22. An impression of a ventral valve of this species.

Figs. 24 – 31. STROPHODONTA INEQUIRADIATA..... 87

24, 25. Profile, and vertical view of a ventral valve with distant coarse striæ.
26. View of a cast of a ventral valve, showing a narrow muscular impression.
27, 28. Front and cardinal views of a cast of a ventral valve, showing muscular and vascular impressions in a very perfect manner.
29. Cast of a large ventral valve.
30, 31. Impressions of the exteriors of dorsal valves, showing sharp distant striæ.

Schoharie Grit.

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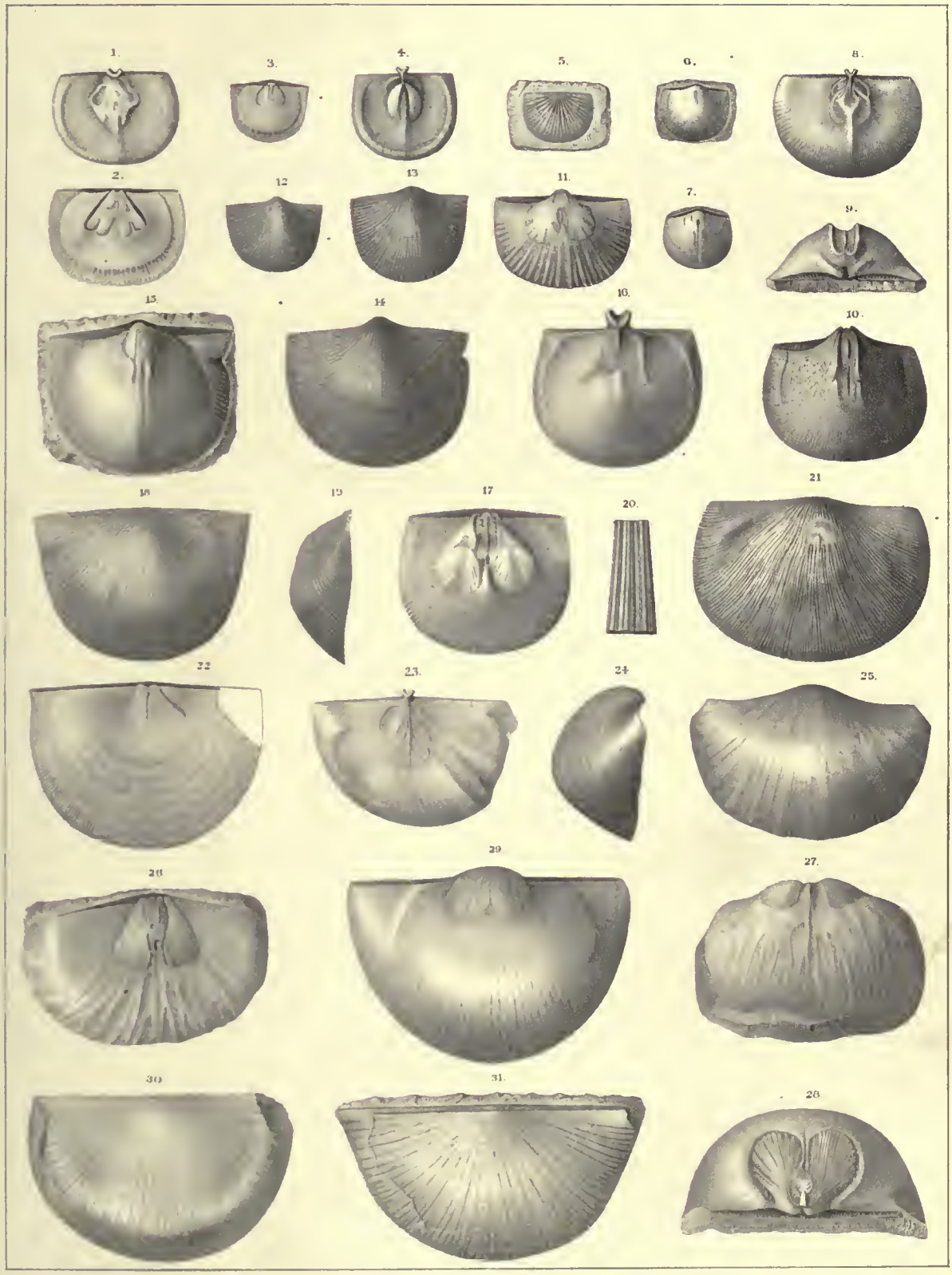

R. P. Whitfield del.

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PLATE 12

PLATE 12.

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Figs. 1–5. STROPHODONTA DEMISSA..... 81

1, 2. Dorsal and ventral views of a small individual.
3–5. Dorsal and ventral views and profile of a larger specimen. This individual is the largest one observed in the Corniferous limestone.

Figs. 6–8. STROPHODONTA INEQUISTRIATA 93

6, 7. Dorsal and ventral views of a specimen of ordinary size.
8. Profile of a larger and very gibbous specimen.

Figs. 9–11. STROPHODONTA PATERSONI. ?..... 89

9. A ventral valve of a specimen of ordinary size, but more convex than usual.
10. A profile of the preceding specimen.
11. An enlargement of the striæ from the same shell.

Fig 12. STROPHODONTA INEQUIRADIATA..... 87

12. The cast of a ventral valve which may belong to this species.

Figs. 13–15. STROPHODONTA PERPLANA..... 92

13. A young individual corresponding in size and character to the original of *S. crenistria* as described in the Geol. Report of the 4th District.
14. A dorsal view of a large individual of the same species.
15 A cast of the ventral valve of the same species in chert, from Indiana.

Figs. 16–18. STROPHOMENA RHOMBOIDALIS..... 76

16. An individual with numerous regular undulations. This is of the type of *S. undulata*, of Vanuxem's Geol. Report of 3d District.
17. A specimen with few strong undulations.
18. A cast of the ventral valve showing few undulations.

UPPER HELDERBERG GROUP.

Corniferous Limestone.

(BRACHIOPODA.)

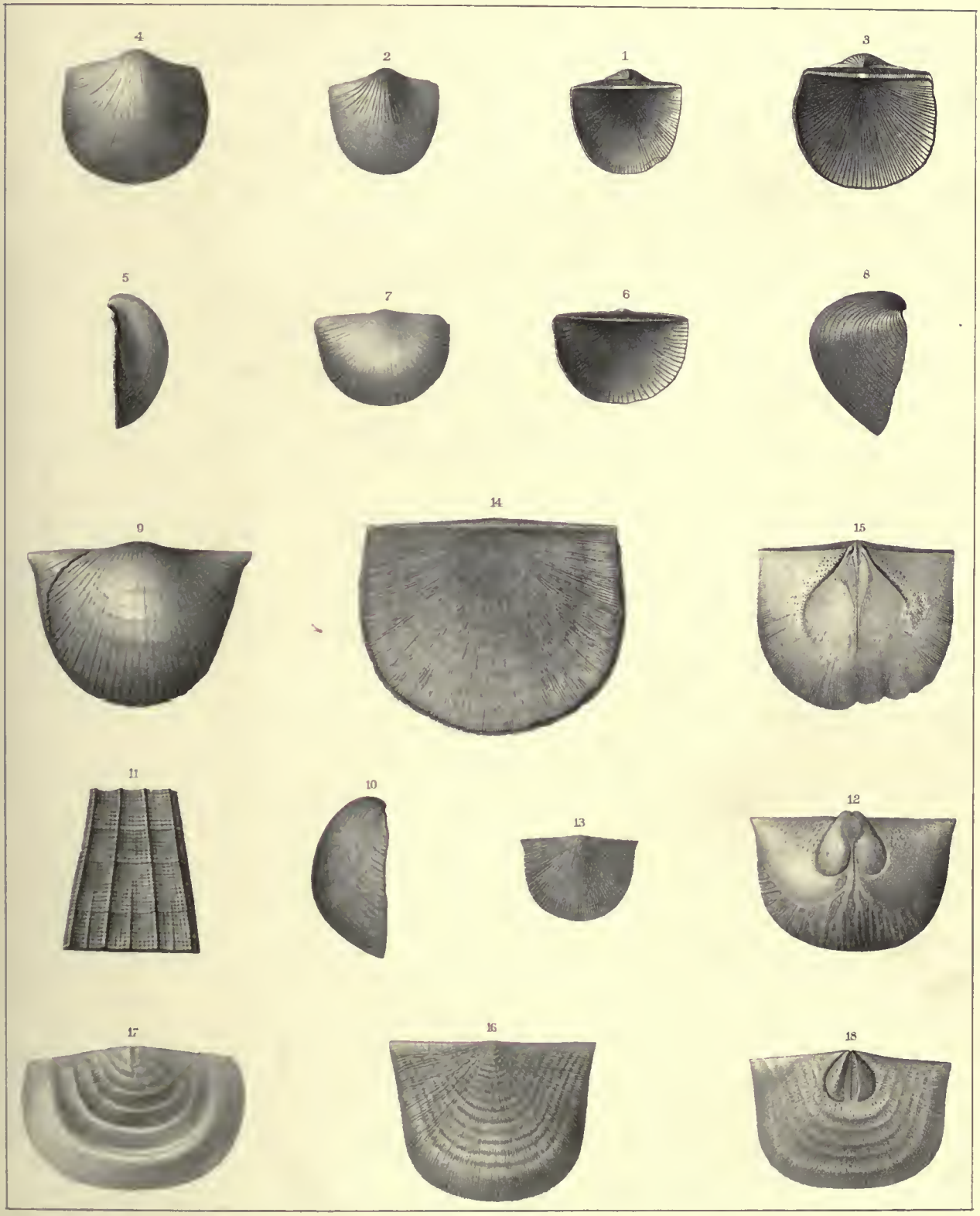

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PLATE 13.

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Figs. 1 – 5. STROPHODONTA PATERSONI..... 89

1. A ventrai valve, of medium size, and depressed convex form.
2. A larger imperfect specimen, showing more distinctly the transverse wrinkles.
3. A large individual in which the striæ are not so strongly marked as in the other specimens.
4. A cast of the ventral valve, showing the muscular impression, and preserving the marks of the exterior striæ.
5. A profile of fig. 3.

Figs. 6 – 11. STROPHODONTA INEQUIRADIATA..... 87

6. A ventral valve of an individual of medium size.
7. A larger individual, having the cardinal extremities produced.
8. A cast of a large ventral valve.
9. A profile of fig. 8.
10. The cast of a ventral valve of this species.
11. An enlargement of the muscular impression of the same specimen.

Figs. 12, 13. STROPHODONTA HEMISPHERICA..... 90

12. A ventral valve of extremely gibbous form, from Port Colborne, Canada West.
13. A profile of the same. This specimen presents some variations from the usual form and character of those from New York and Ohio, which have been referred to this species.

UPPER HELDERBERG GROUP.

Corniferous Limestone.

(BRACHIOPODA.)

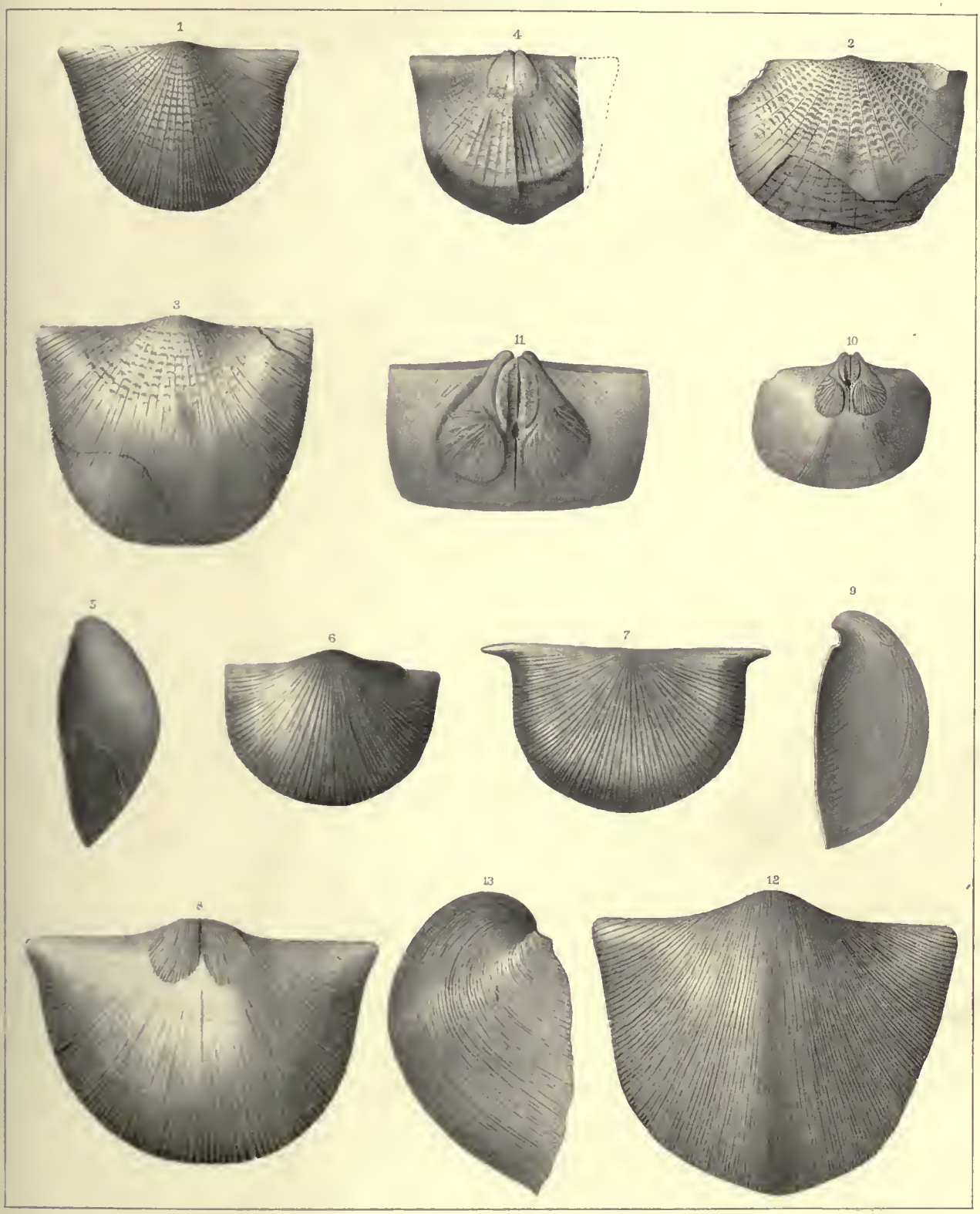

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PLATE 14.

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Fig. 1. STROPHODONTA AMPLA..... 93

1 *a*. A dorsal view of a young individual.

1 *b*. An impression of a dorsal valve of a specimen of medium size, showing the cavity left by the cardinal process.

1 *c*. A ventral valve of a larger individual.

1 *d*. A profile of the specimen fig. 1 *c*.

1 *e*. A dorsal view of a large individual.

1 *f*. An enlargement of the surface, showing the transverse striæ and the elongate, pustulose elevations upon their surface.

1 *g*. The cardinal area of the ventral valve with a narrow, linear callosity closing the deltidium, and a smooth triangular area which is continuous with the other portions of the same surface, and has apparently never been a foramen.

1 *h*. The interior of a ventral valve, showing the strong flabelliform muscular scar. The margin of the area is broken (a usual condition) by the removal or the separation of the dorsal valve.

1 *i*. A cast of the ventral valve from the Schoharie grit, showing the muscular scar and the strongly punctate surface.

Fig. 2. STROPHODONTA CONCAVA..... 96

2 *a*. View of a ventral valve which is constricted just below the cardinal extremities.

2 *b*. A profile of the same.

2 *c*. The interior of a dorsal valve, showing the muscular impressions and cardinal process.

2 *d*. A cardinal view of a cast of the ventral valve, showing the muscular impressions.

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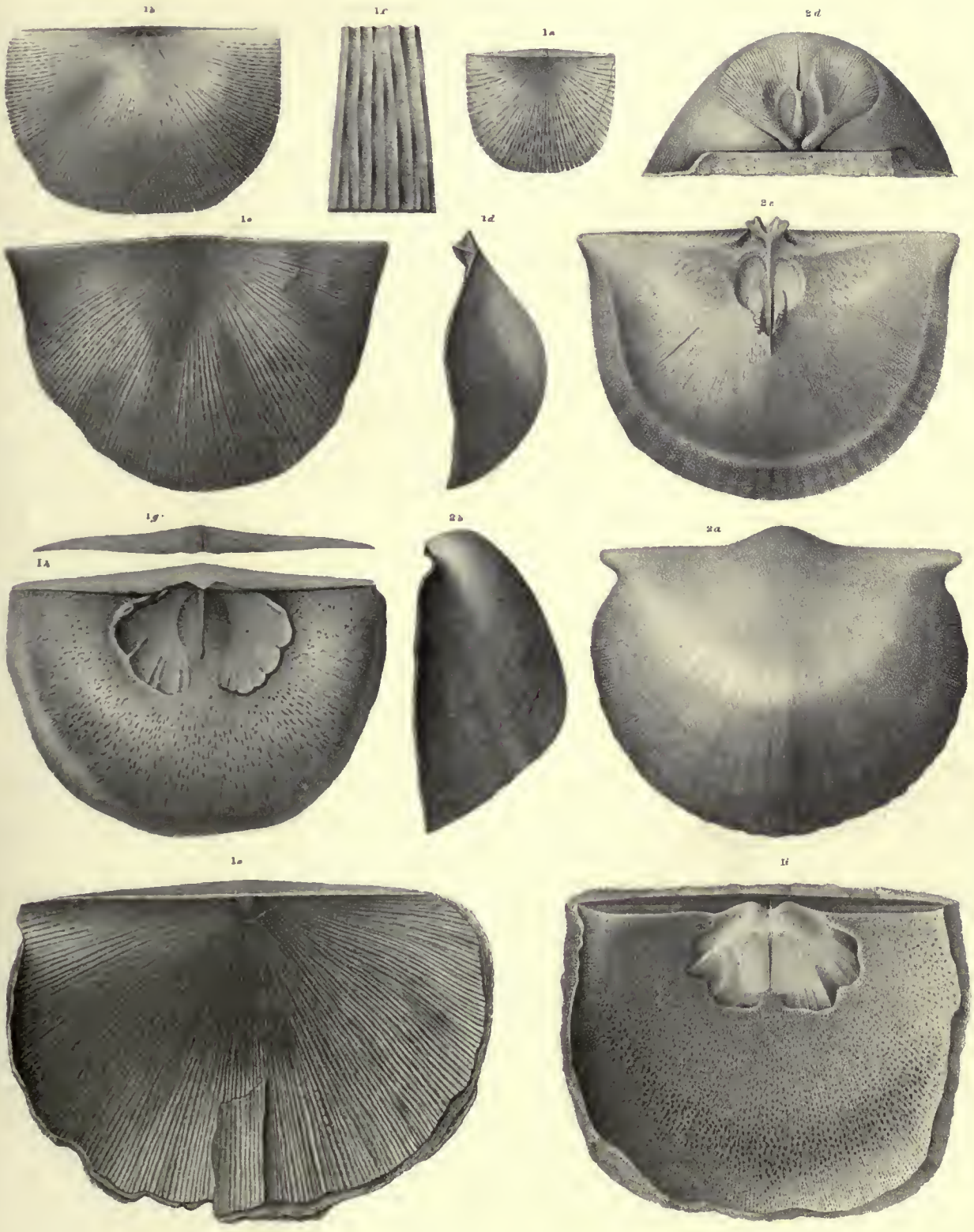

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PLATE 15.

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Figs. 1 – 5. STROPHODONTA CONCAVA 96

1. Interior of the dorsal valve of a young individual, showing the muscular impressions, cardinal process, socket plates and crenulated hinge; enlarged to two diameters.
2. Interior of a deeply concave dorsal valve, showing very large socket plates.
3. Profile of specimen, fig. 2.
4. Enlargement to two diameters of the central part of an adult dorsal valve, showing the muscular impression, cardinal process, socket plates and crenulated hinge.
5. Cardinal view of the specimen, fig. 4, showing the elevation of the cardinal process and socket plates, crenulated hinge, and the absorption of the base of the cardinal process, to accommodate the margin of the opposite valve; enlarged to two diameters.

Fig. 6. STROPHODONTA PATERSONI 89

6. Interior of the dorsal valve of a specimen, referred with some doubt to this species.

Figs. 7, 8. STROPHODONTA PERPLANA 98

7. Interior of a dorsal valve, showing the muscular impression, cardinal process and crenulated hinge.
8. Cardinal view of specimen, fig. 7, showing the elevation of the cardinal process.

Figs. 9, 17. STROPHODONTA JUNIA = S. TEXTILIS of text 108

9. Exterior of a ventral valve, from the Tully limestone.
17. Cardinal view of a specimen, showing hinge area, deltidium, etc.

Figs. 10, 11. STROPHODONTA INEQUISTRIATA 106

10. Interior of a ventral valve, showing the arrangement of the muscular impressions; enlarged to two diameters.
11. Enlargement of an imperfect dorsal valve, showing the highly elevated muscular impressions, cardinal process, etc.

Fig. 12. STROPHODONTA SUBDEMISSA 414

12. Interior of a dorsal valve of this species, from the Hamilton group of Iowa.

Figs. 13, 14. STROPHODONTA MUCRONATA 111

13. A ventral valve, showing mucronate extensions of the cardinal extremities.
14. A dorsal view of a specimen without mucronate extensions.

Figs. 15, 16. STROPHOMENA RHOMBOIDALIS? 414

15. Exterior of a ventral valve, from the Waverly sandstone series of Ohio
16. Interior of a dorsal valve, showing the muscular impressions, cardinal process, etc., from the Waverly sandstones of Ohio.

(BRACHIOPODA)

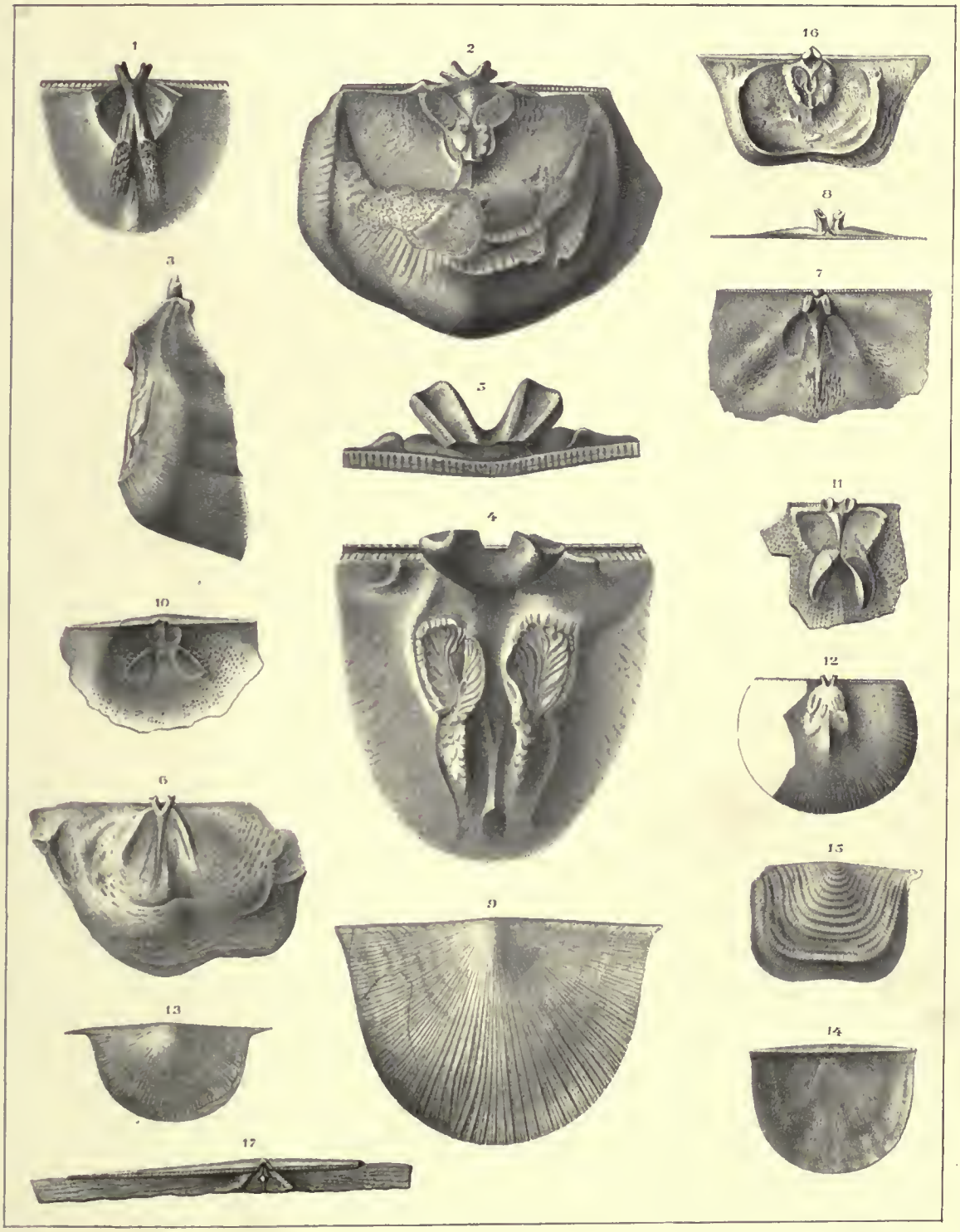

PLATE 16.

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Fig. 1. STROPHODONTA CONCAVA..... 96

1 *a*. A ventral valve which is carinate along the centre.

1 *b*. A dorsal view showing the area of both valves, etc.

1 *c*. A profile of specimen fig. 1 *b*.

1 *d*. A large ventral valve which is less convex than the usual forms and somewhat undulated or sub-plicated on the margin.

1 *e*. The exterior of a dorsal valve, showing the extension of the cardinal process above the hinge line.

1 *f*. The interior of the specimen fig. 1 *e*, showing the muscular impressions, cardinal process, crenulated hinge line, etc.

1 *g*. A profile of the same, showing the geniculation in front, and the muscular scar.

1 *h*. The interior of a ventral valve, showing the area and muscular impressions.

UPPER HELDERBERG GROUP.

(BRACHIOPODA.)

PLATE 17.

Page

Fig. 1. STROPHODONTA PERPLANA..... 98

1 *a*. A young individual.

1 *b*. An individual of medium size, having the cardinal angles extended.

1 *c*. A large ventral valve, having a cicatrix along the median line—a feature of not uncommon occurrence in this species.

1 *d*. A dorsal valve which is somewhat contracted on the hinge line.

1 *e*. An enlarged cardinal view, showing the areas of the two valves and a slight callosity on the dorsal area. The area is much wider than usual.

1 *f*. The exterior of a ventral valve from the Hamilton group, at Rock Island, Illinois, showing the unequal or fasciculate striæ.

1 *g*. The interior of the same, showing the muscular impression.

1 *h*. The interior of a ventral valve from the Hamilton group of New York.

1 *i*. The cast of a ventral valve, showing more distinctly the large flabelliform divaricator muscular impressions, and the small occlusor muscular impressions.

1 *k*. An enlargement of the interior of a fragment of a dorsal valve, showing the peculiar form of the cardinal process. The continuation of the process along the centre, forming the median septum, is exfoliated.

1 *l*. A further enlargement of the hinge line, cardinal process, etc., from another individual. The cordiform extremities of the process show the striated surface for the attachment of the muscles.

1 *m*. A longitudinal section.

1 *n*. An enlargement of the surface striæ of a New York specimen, showing the sub-equal striæ.

1 *o*. An enlargement from a Rock Island specimen, (1 *f*,) showing the alternating or fascicular arrangement of striæ.

Fig. 2. STROPHODONTA DEMISSA..... 101

2 *a*. A young individual.

2 *b*, *c*, *d*. Ventral valves of the ordinary form.

2 *e*. A dorsal valve having strong sharp striæ.

2 *f*, g. Dorsal valves of the ordinary form, showing the area.

2 *k*, *l*, *m*. Ventral, dorsal and profile views of a large individual.

2 *n*. Profile of a moderately convex specimen.

2 *o*. A profile of the specimen fig. 2 *c*, which is more than usually gibbous.

2 *p*. An enlarged cardinal view, showing the areas of the two valves which are destitute of a central callosity.

2 *r*. The interior of a ventral valve, showing the muscular impressions. The area has been broken by the separation of the opposite valve.

2 *s*. The interior of a dorsal valve, showing the muscular impressions, the cardinal process and crenulated cardinal margin.

STROPHODONTA SUBDEMISSA..... 214

2 *h*, *i*. Dorsal and ventral views of a specimen from Rock Island, Illinois.

HAMILTON GROUP.

(BRACHIOPODA.)

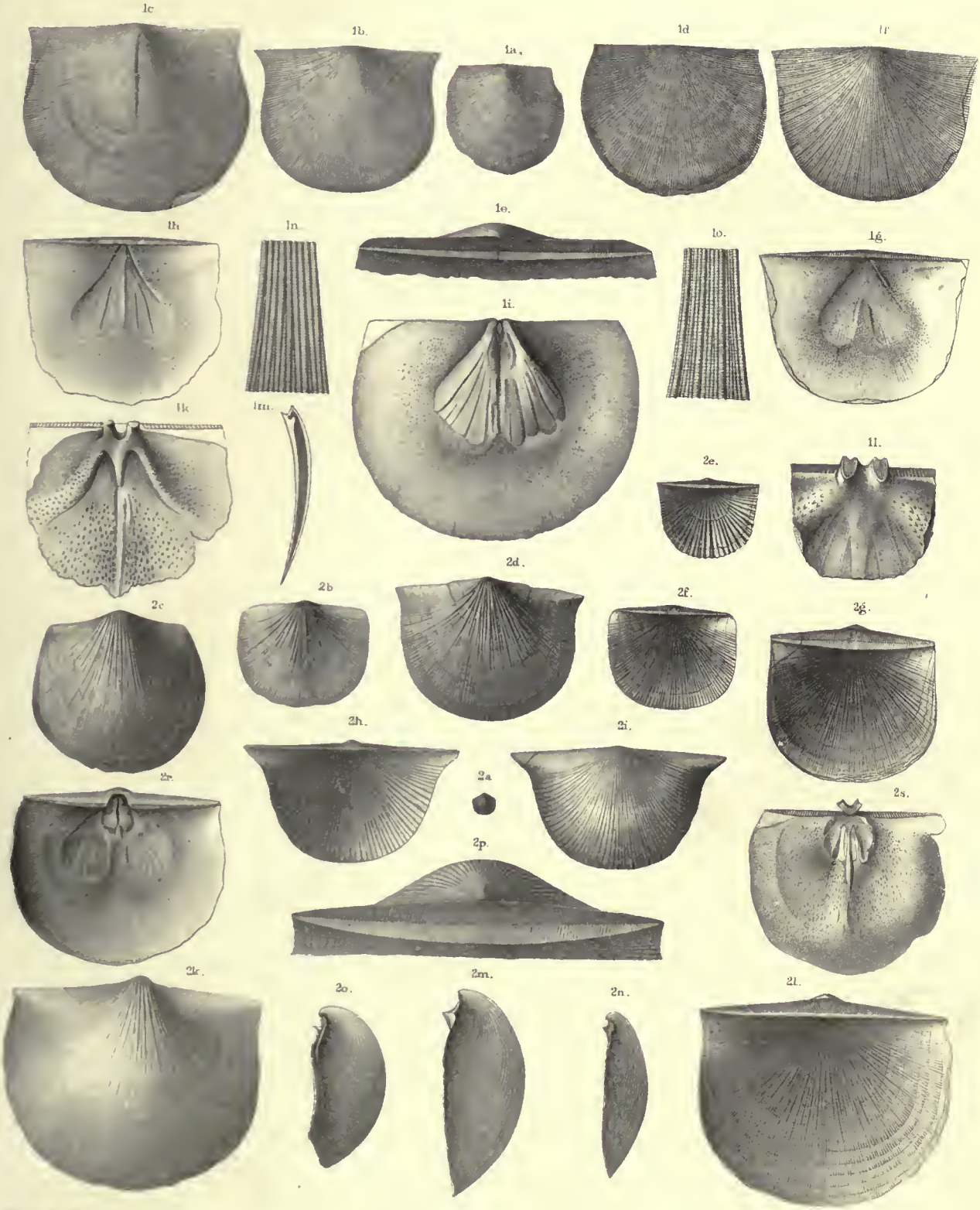

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PLATE 18.

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Fig. 1. STROPHODONTA NACREA..... 104

1 *a*, *b*, *c*. Ventral valves of this species, showing varieties of form.
1 *d*. A dorsal view of fig. 1 *c*.
1 *e*. A profile of the same.
1 *f*. A profile view of 1 *a*.
1 *g*. Interior of the ventral valve. The open deltidium is due to accident.
1 *h*. The interior of a dorsal valve.

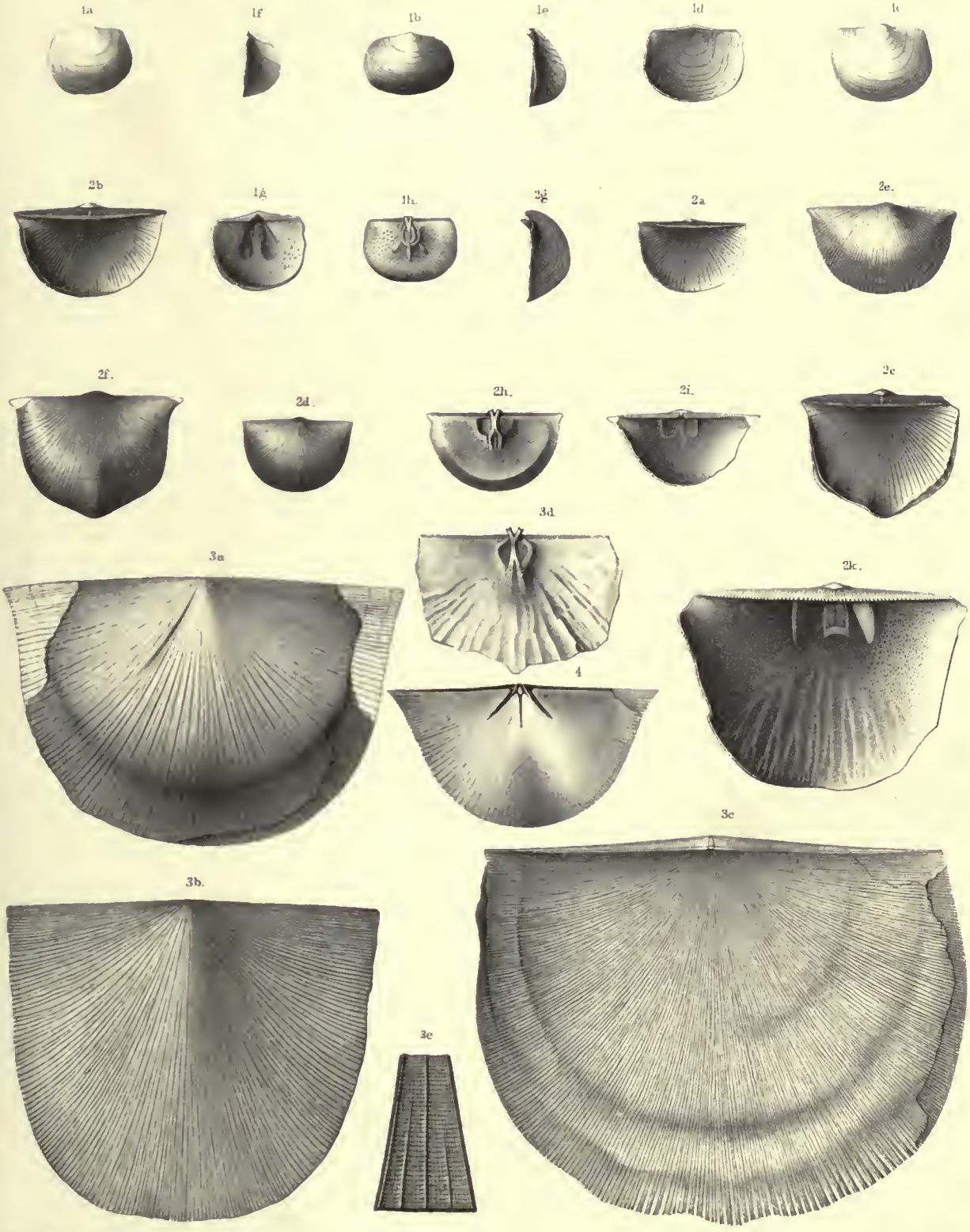
Fig. 2. STROPHODONTA INEQUISTRIATA..... 106

2 *a*, *b*, *c*. Dorsal views of three individuals, showing the extremes of the ordinary forms.
2 *d*, *e*, *f*. Ventral views of the preceding specimens.
2 *g*. A profile of fig. 2 *b*.
2 *h*. The interior of a dorsal valve.
2 *i*. The interior of a ventral valve.
2 *k*. The interior of a ventral valve enlarged to two diameters, showing the peculiar dental lamellæ and the vascular impressions.

Fig. 3. STROPHODONTA TEXTILIS 108

3 *a*. A ventral valve of this species.
3 *b*. A ventral valve which is more elongated than the usual form.
3 *c*. The dorsal side of a large individual, showing the cardinal area of the ventral valve and a narrow callosity in the centre.
3 *d*. The interior of a portion of an imperfect dorsal valve, showing the small muscular area and slender cardinal process.
3 *e*. An enlargement of the surface, showing the character of striæ, etc.
4. A cast of a ventral valve which is apparently of the same species, much extended on the hinge line.

(BRACHIOPODA)



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Figs. 1–5. STROPHODONTA CAYUTA..... 110

1. A cast of a small ventral valve.
2. The more common and prevailing form among specimens of larger dimensions.
3. A ventral cast, which is very gibbous and sub-plicate in the middle, with the cardinal extremities greatly extended.
4. An enlargement of the surface striæ, as shown in an impression in the stone.
5. An enlargement of the ventral muscular impression, and a part of the cardinal line, to show the crenulations.

Figs. 6, 7. STROPHODONTA CŒLATA..... 112

6. An impression in a fine sandstone preserving the marks of muscular impressions, etc.
7. The impression of a convex dorsal valve supposed to be of the same species.

Figs. 8–12. STROPHODONTA DEMISSA..... 114

8, 9, 10. Casts of ventral valves, of variable and somewhat distorted forms.
11. The cast of a ventral valve of the ordinary form of the species.
12. The cardinal view of the same.

Figs. 13–16. STROPHODONTA PERPLANA, var. NERVOSA..... 113

13. The interior of a ventral valve having the form and general aspect of *S. perplana*, but with the fine striæ characteristic of *S. nervosa*.
14. A specimen having the cardinal extremities greatly produced. This specimen is the original of *S. nervosa*
15. A portion of a large ventral valve with sharp, strong, undulating striæ, which are sometimes elevated into pustules and again abruptly depressed. This character of surface prevails in all the specimens in certain beds of the rock.
16. An enlargement of a part of the surface of the preceding specimen, showing the peculiar features of the striæ.
17, 18, 19. These specimens are casts of the ordinary forms of the *S. perplana* = *S. delthyris* (Conrad), as it occurs in the Chemung group.

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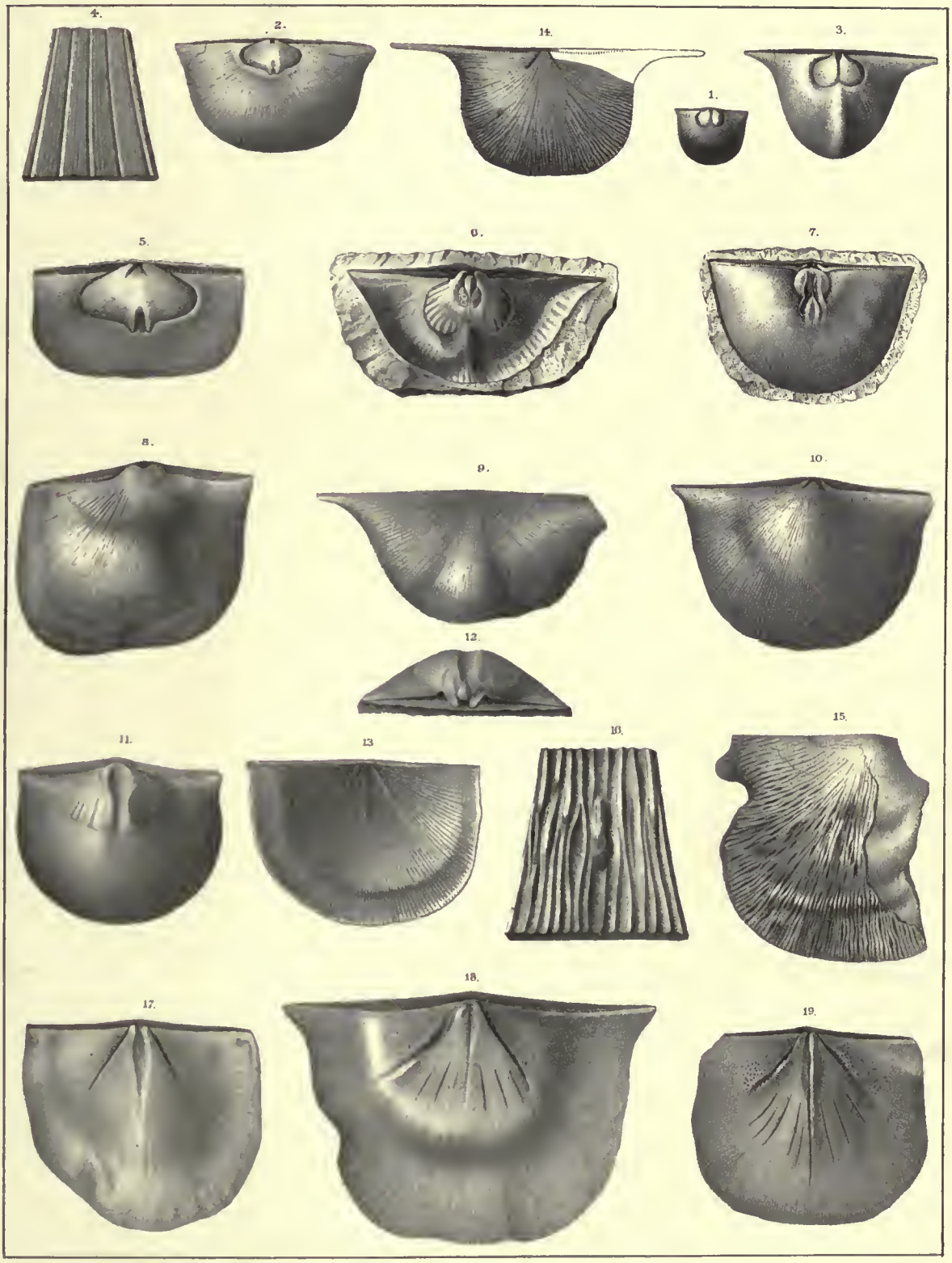

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PLATE XIX.

PLATE 20.

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Fig. 1. CHONETES MUCRONATA 124

1 *a*. Ventral valve of this species; being a small specimen enlarged to two diameters. From the Corniferous limestone.

1 *b*. Ventral valve of the natural size. From the Corniferous limestone.

1 *c*. The specimen fig. 1 *b*, twice the natural size.

1 *d*. The profile of fig. 1 *c*.

Fig. 2. CHONETES MUCRONATA ? 124

2. The figure is twice the natural size of the specimen; the plications strong and angular.

Fig. 3. CHONETES LINEATA 121

3 *a*. A ventral valve natural size.

3 *b*. The interior of a ventral valve, with a piece of the dorsal valve attached.

3 *c*, *d*. Dorsal and ventral views of specimens twice the natural size.

3 *e*. An enlarged figure from the cast of a ventral valve.

3 *f*. A section of the two valves.

Fig. 4. CHONETES YANDELLANA 123

4 *a*, *b*. Dorsal views of specimens of the natural size.

4 *c*. A ventral view of the specimen 4 *b*.

4 *d*. A longitudinal section of the two valves.

4 *e*. The specimen fig. 4 *a*, enlarged to two diameters.

4 *f*. An enlargement of the interior of a ventral valve.

4 *g*. An enlargement of the interior of a dorsal valve.

Fig. 5. CHONETES ACUTIRADIATA 120

5 *a*, *b*. Ventral views of two individuals, one being much more convex than the other.

5 *c*. A profile of fig. 5 *a*.

Fig. 6. CHONETES HEMISPHERICA 118

6 *a*, *b*. Ventral views of a small and a large individual.

6 *c*. A profile of 6 *b*.

6 *d*. A cardinal view showing the spines upon the margin.

Fig. 7. CHONETES ARCUATA 119

7 *a*. A dorsal view of an individual.

7 *b*, *c*. Ventral views of different specimens.

7 *d*. A profile of 7 *c*.

7 *e*, *f*. Ventral and cardinal views of a cast of this species, showing the muscular impression and apparently crenulated border caused by the spine-tubes.

Figs. 8, 9. STROPHODONTA CALLOSA 82

8. The interior of a dorsal valve, taken from a gutta-percha impression.

9 *a*. A cast of the interior of the ventral valve, showing the muscular impression and the thickened border of the valve.

9 *b*. A cardinal view of the preceding individual. The figures are all enlarged to two diameters.

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PLATE 21

Page

Fig. 1. CHONETES MUCRONATA..... 124

1 *a*. A ventral valve, natural size.

1 *b*. An enlargement of fig. 1 *a*, showing more distinctly the character of the spines.

1 *c*. A profile of the same. This form has few strong striæ upon the surface.

1 *d, e*. A dorsal view, and an enlargement of the same, from another individual. The surface is marked by more numerous striæ than the specimens 1 *a*, 1 *b*.

1 *f, g*. A ventral view, and the same enlarged. This one is intermediate in number of striæ between figs. 1 *a* and 1 *d*. The above figures are from specimens from the Marcellus shale.

Fig. 2. CHONETES SETIGERA..... 129

2 *a, b*. The ventral valve, natural size and enlarged.

Fig. 3. CHONETES KONINCKIANA (cited)..... 136

3. This figure of a specimen of this species is given for comparison with the varieties of *C. coronata*.

Fig. 4. CHONETES SCITULA..... 130

4 *a, b*. Ventral and dorsal views of a specimen, natural size, of the ordinary proportions.

4 *c*. A ventral valve of a smaller individual.

4 *d*. A profile specimen of fig. 4, *a, b*.

4 *e*. An enlargement of the interior of the ventral valve.

4 *f*. An enlargement of the interior of the dorsal valve.

Fig. 5. CHONETES LEPIDA..... 132

5 *a, b*. Ventral and dorsal views of a large individual.

5 *c*. An enlargement of a ventral valve.

5 *d*. An enlargement of the dorsal side, showing the area and spines of the ventral valve.

5 *e*. An enlargement of the interior of a dorsal valve, from which the cardinal process has been broken.

Fig. 6. CHONETES PUSILLA..... 128

6 *a, b*. A ventral and profile view of a specimen of the ordinary size.

6 *c*. A specimen of the same species, from the Corniferous limestone, showing an extension of the cardinal extremities.

Figs. 7, 8. CHONETES DEFLECTA..... 126

7 *a, b, c*. Ventral, dorsal and profile views of an individual of the ordinary form and size.

7 *d*. A ventral view of an individual which is a little more transverse than the others.

7 *e*. An interior of the dorsal valve of the natural size.

7 *f*. An enlargement of the same, showing the muscular impressions, cardinal process, etc.

7 *g*. An enlargement of the interior of the ventral valve.

8 *a*. The dorsal valve of a specimen referred to *C. gibbosa*.

8 *b, c*. A ventral and profile view of the original of *C. gibbosa*, the specific distinction of which is doubtful, as noticed under *C. deflecta*, pp. 126 and 128.

HAMILTON GROUP.

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PLATE 21—Continued.

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Figs. 10. (9, 11, 12.) CHONETES CORONATA..... 133

10 *a*, *b*. Dorsal and ventral views of a small individual of this species.

10 *c*, *d*. Ventral and profile views of a specimen of medium size and somewhat more than usual gibbosity.

10 *e*, *f*. A ventral and profile view of a specimen which is more extended on the hinge line, and a little less gibbous than the preceding.

10 *g*. A dorsal view, showing the area, etc., of a specimen which is unusually short on the hinge line.

10 *h*, *i*. The exterior and interior of a large ventral valve.

10 *k*. Interior of a dorsal valve of medium size, showing a quadruple termination to the cardinal process.

10 *l*. Interior of a larger dorsal valve where the cardinal process has only two divisions. The reniform muscular impression, characteristic of the genus, is very distinctly shown. The foregoing specimens are all from the soft shales of the formation in New York.

The following are introduced for comparison with authentic specimens of *C. coronata*.

9 *a*. *b*. Ventral and dorsal views of *C. tuomeyi*. These specimens and the two following figures are from Bake-oven, Ill., the original locality of the species, labelled by Messrs. Norwood & Pratten, and received from Dr. Norwood.

11. A ventral valve of *C. maclurea*.

12. Ventral valve of *C. martini*, partially denuded of its shell.

Fig. 13. CHONETES SYRTALIS (referred to)..... 133 and 135

13 *a*, *b*. Exterior of shells of this species.

13 *c*. Casts of a ventral valve of the same.

13 *d*. A cast of the interior of a dorsal valve. The outline of the reniform impression is not distinctly preserved, and in consequence presents a different expression from fig. 10 *l*.

PLATE 22.

Page

Figs. 1 – 5. CHONETES SETIGERA..... 129 and 142

1. A ventral valve enlarged to two diameters, showing two spines on each side of the apex.
2. A more transverse form of the same (natural size), the spines not being preserved. These specimens are from the Chemung group near Meadville, Pa.
3. A specimen preserving three spines on each side of the beak. This specimen is from Penfield, Ohio, and has the general features of *C. setigera*, but there may be some question as to absolute identity.
4. A small individual (twice enlarged) from Painted Post, N. Y. This, and other specimens from the same locality, are proportionally longer than the typical forms.
5. A portion of the surface striæ of a specimen from the Marcellus shale, six times enlarged.

Figs. 6 – 11. CHONETES SCITULA .... 130 and 141

6. A cast of the ventral valve of a very transverse specimen, twice enlarged; the spines are very short.
7. A specimen having the base a little more rounded than is usual in this species; twice enlarged.
8. A specimen of the natural size, which is slightly distorted. From shales of the Chemung group near Tioga, Pa.
9. An enlargement to two diameters from a cast of this species, showing the muscular and vascular impressions. The specimen is from the Hamilton group in Virginia, and has a more rounded outline than the prevailing forms in New York.
10. A cast of this species, preserving strong marks of the surface striæ, and casts of the spine tubes in the area. Chemung group, Cattaraugus county, N. Y. Enlarged.
11. An enlargement of the area and upper portions of a specimen from the Hamilton group; showing the area, foramen and cardinal process; the spine tubes of the area in their inclination towards the apex of the valve, and the bases of some of the spines turning directly outwards from the margin. (See pages 116 and 117.)

Figs. 12, 13. CHONETES LEPIDA..... 132 and 142

12. A specimen from the Marcellus shale, twice enlarged.
13. A specimen from the Chemung group at Forestville, six times enlarged. The specimens of this species in the Chemung group are minute, with the striæ coarser than those of Hamilton group, but otherwise having similar features.

Figs. 14, 15. CHONETES ILLINOISENSIS (referred to) 145

14. An individual from which the spines have been removed; natural size.
15. A specimen of somewhat different form, preserving the spines of the hinge line; twice enlarged. These specimens are from the shaly sandstones of Eastern Ohio, associated with *C. logani*.

Figs. 16 – 28. CHONETES LOGANI var. AURORA..... 137

16. A specimen of natural size.
17. A specimen enlarged to three diameters.
18. An enlargement to six diameters of the surface striæ. The preceding figures are from specimens in the Tully limestone of New York.

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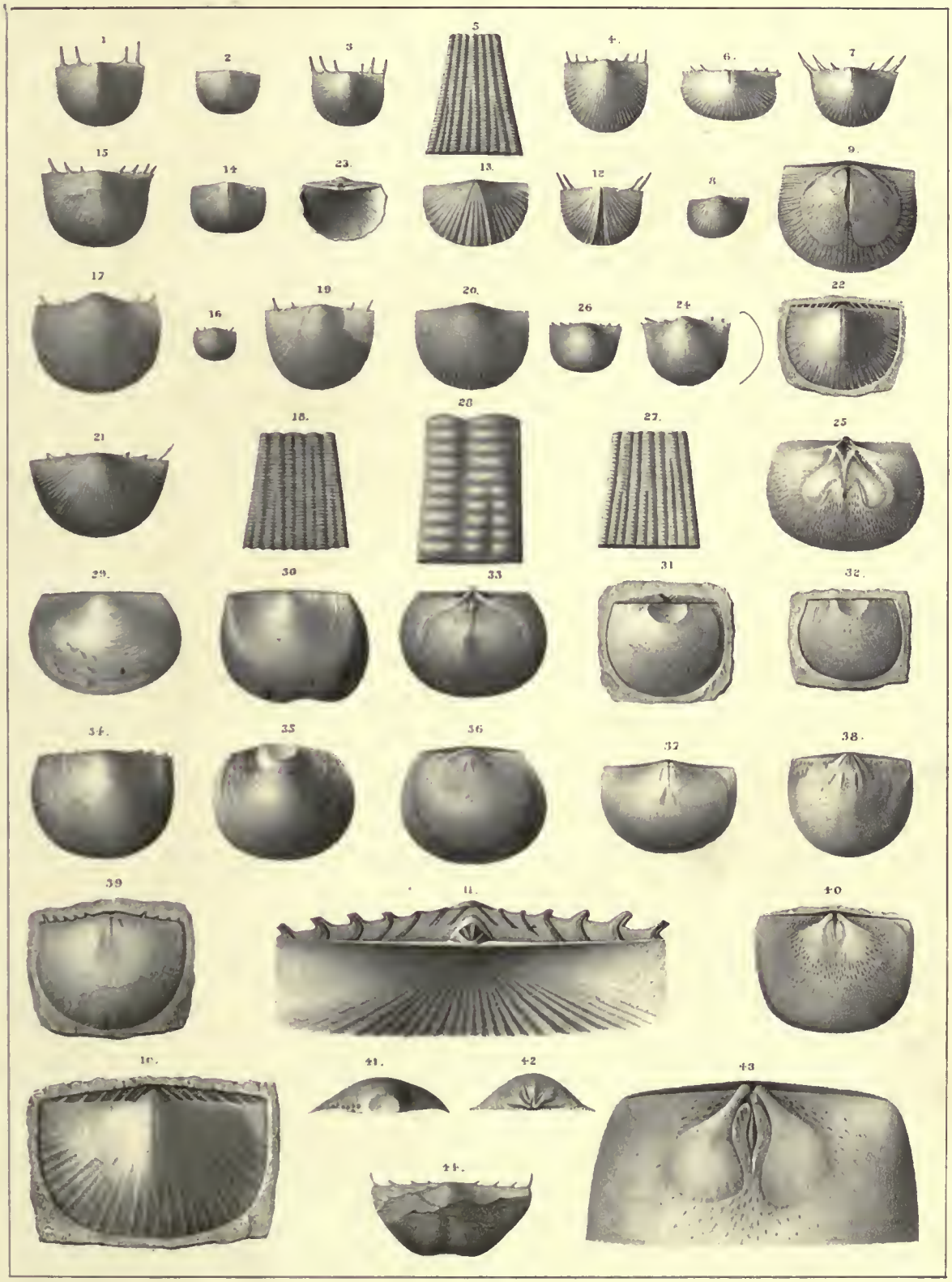

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PLATE 22—Continued.

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19, 20. Specimens from the shales of Eastern Ohio, enlarged to three diameters to correspond with the enlargement of the specimen from the Tully limestone.

21. A specimen of somewhat different form from the same locality as the last, enlarged to two diameters.

22. A cast from the same locality as the last, enlarged to three diameters, showing the filling of the spine tubes in the area.

24. A ventral view of another individual, showing the spines of the cardinal margin; the curved line by the side of the figure shows the convexity of the valve.

25. The interior of a dorsal valve enlarged to two diameters. These specimens usually preserve the surface marking but obscurely.

23. A dorsal view, natural size. This, with the two following figures, are from specimens from the arenaceous beds below the Burlington limestone, at Burlington, Iowa.

26. A specimen from the oolitic limestone at Burlington, Iowa, in which the surface markings are well preserved; natural size.

27. A portion of the surface striæ of specimen fig. 26; enlarged to six diameters, for comparison with fig. 18.

28. A portion of the surface enlarged twenty-four times, showing the peculiar undulating rugæ.

Figs. 29–43. CHONETES MURICATA 143

29, 30. Impressions of the exterior of the dorsal valve of this species, one of them showing the marks of a few surface spines.

31, 32. Impressions of the exterior of dorsal valves, with truncated apices, one of them showing the impression of the cardinal process. Both specimens show marks of numerous surface spines.

33. A representation of the interior of the dorsal valve, obtained from an artificial cast of an impression left in the stone.

34, 35. Ventral valves of two individuals, one of them having a truncated beak. Fig. 34 shows a few cardinal spines, as usual in *Chonetes*, while there are numerous smaller ones on the surface. Fig. 35 has a shorter hinge line, with wrinkled ears, which are studded with spines as in *Productus*.

36, 37, 38. Specimens of the casts of the ventral valves having the features obscurely preserved, showing three forms of the shell.

39. A cast of the ventral valve, with adhering stone, preserving impressions of the cardinal spines.

40. A cast of the ventral valve, showing the marks of the muscular impressions very distinctly.

41. A cardinal view of the specimen fig. 35.

42. A cardinal view of the specimen fig. 38.

43. An enlargement of part of a ventral valve, combining the characters of muscular impressions, etc., observed in several individuals.

Fig. 44. CHONETES ARCUATA 119

44. A cardinal view, showing the distant slender spines. From the Corniferous limestone.

PLATE 23.

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Figs. 1 – 3, 9 – 11. PRODUCTELLA NAVICELLA..... 156

1, 2. Ventral views of two individuals, from the Corniferous limestone.
3. Profile view of specimen fig. 1.
9 – 11. Dorsal, ventral and profile views of a more elongated specimen, from the Hamilton group.

Figs. 4, 5. PRODUCTELLA SUBACULEATA?... 154

4. Ventral valve of a specimen, from the Falls of the Ohio, showing spine-bases and one long spine.
5. Interior of a dorsal valve of a similar character, from East Victor, New York.

Figs. 6 – 8. PRODUCTELLA SPINULICOSTA ?=*P. shumardiana*..... 160

6, 7, 8. Ventral, profile and cardinal views of a specimen from the Corniferous limestone near Louisville, Ky.

Figs. 12 – 24. PRODUCTELLA TRUNCATA..... 160

12. Interior of a dorsal valve, enlarged to two diameters, from the Marcellus shale.
13. An enlargement of a portion of the interior of a dorsal valve, showing the cardinal process.
14. An impression of the exterior of the dorsal valve, showing the area of both valves.
15. View of a ventral valve preserving several of the spines; from the Marcellus shale.
16. The exterior of a dorsal valve, from the limestones of the Marcellus shales.
17. A ventral valve, of small size, having the beak but slightly truncated.
18, 19, 20. Ventral, cardinal and profile views of a small individual, having a large truncation; from the limestones of the Marcellus shales, enlarged to three diameters.
21, 22. Interiors of dorsal valves.
23. An impression of the dorsal valve, and the area and beak of the ventral valve, showing a narrow deltidium.
24. A ventral view of a specimen which is somewhat largely truncate. Figs. 21 – 24, are from specimens from the Hamilton group. Figs. 12, 14 – 17, 21 – 23, are enlarged to two diameters; fig. 13 to six diameters, and fig 24 to three diameters.

Figs. 25 – 34. (35–37). PRODUCTELLA SPINULICOSTA..... 160

(All the figures of natural size except fig. 26.)

25. The interior of a dorsal valve.
26. An enlargement of a portion of the above to three diameters to show the cardinal process.
27. A ventral valve of a small broad form.
28. Ventral view of an individual of larger size.
29. Profile of the same.
30. Cardinal view of the same.
31. A smaller individual imbedded in the rock, and showing spines attached.
32. Profile view of a specimen from the Tully limestone; probably of this species.
33. Cardinal view of the same.
34. A fragment of shale with crushed specimens of this species, preserving the slender spines.
35. A ventral view of a specimen from the limestone of the Marcellus shale, which closely resembles the *P. shumardiana* from the calcareous bands below the Burlington limestone.
36. Ventral view of a specimen of *P. shumardiana*, from Burlington, Iowa.
37. Profile of the same.

Figs. 38 – 40. PRODUCTELLA DUMOSA..... 162

38. Ventral view of a small specimen.
39. Profile of the same.
40. Ventral view of a larger specimen, showing the base of spines remaining, and the pustules becoming elongated and assuming the form of costæ. The specimen is a little crushed.

Figs. 41 – 44. PRODUCTELLA TULLIA..... 164

41. An impression of the exterior of a dorsal valve preserving the cardinal process; from the Hamilton group.
42. A dorsal valve of larger size; from the shale of the Hamilton group.
43. A large dorsal valve from the Tully limestone.
44. An enlargement of the pustules and surface striæ, as shown in figs. 41 & 42.

Figs. 45, 46. PRODUCTELLA EXANTHEMATA..... 163

45, 46. The interiors of the dorsal valves of two individuals, natural size.

Figs. 47, 48. PRODUCTELLA SP ?..... 165

47. The interior of a dorsal valve, natural size.
48. A profile of the same.

Fig. 49. PRODUCTELLA SUBALATA..... 165

49. Ventral view of an individual, from the calcareous shale at Rock Island, Illinois.

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PLATE 24.

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Figs. 1 – 9. PRODUCTELLA RARISPINA... 170

1. The ventral valve of a young individual.
2, 3, 4. Three views of an adult individual, showing an irregular fold on the ventral valve.
5. A ventral valve, preserving two of the spines and the bases of several others.
6. A ventral valve, which is unusually symmetrical, and retains the marks of very few spines.
7. A cardinal view of a ventral valve.
8. The interior of a dorsal valve.
9. Profile of specimen fig. 8.

Figs. 10 – 16. PRODUCTELLA BOYDII..... 169

10. The ventral valve of a young individual.
11, 12. The interior of dorsal valves, showing pustules from the indentations of the exterior.
13 – 15. Ventral valves of this species, preserving some of the spines.
16. A profile view of the specimen fig. 15.

Fig. 17 – 29. PRODUCTELLA HIRSUTA..... 166

17. The ventral valve of a young individual.
18, 19. Ventral valves of large individuals.
20. An impression of a dorsal valve.
21, 22. Ventral valves preserving some of the submarginal spines.
23. A profile of the specimen fig. 22.
24. A symmetrical ventral valve with short hinge line.
25. A profile view of the preceding.
26. A large and somewhat distorted ventral valve preserving some of the submarginal spines.
27. The interior of a dorsal valve with cardinal process.
28. An enlargement of the cardinal process from fig. 27.
29. An enlargement of a portion of the surface, from a well preserved specimen.

Figs. 30 – 37. PRODUCTELLA HIRSUTA var. RECTISPINA..... 168

30. The dorsal valve of a small individual.
31. A convex ventral valve.
32. A large ventral valve.
33. An impression of the exterior of a large dorsal valve.
34. A large and somewhat distorted ventral valve.
35. A profile view of the same.
36. The interior of a large ventral valve from which the shell has been mostly removed, preserving the submarginal spines.
37. The interior of a dorsal valve from an impression in the stone.

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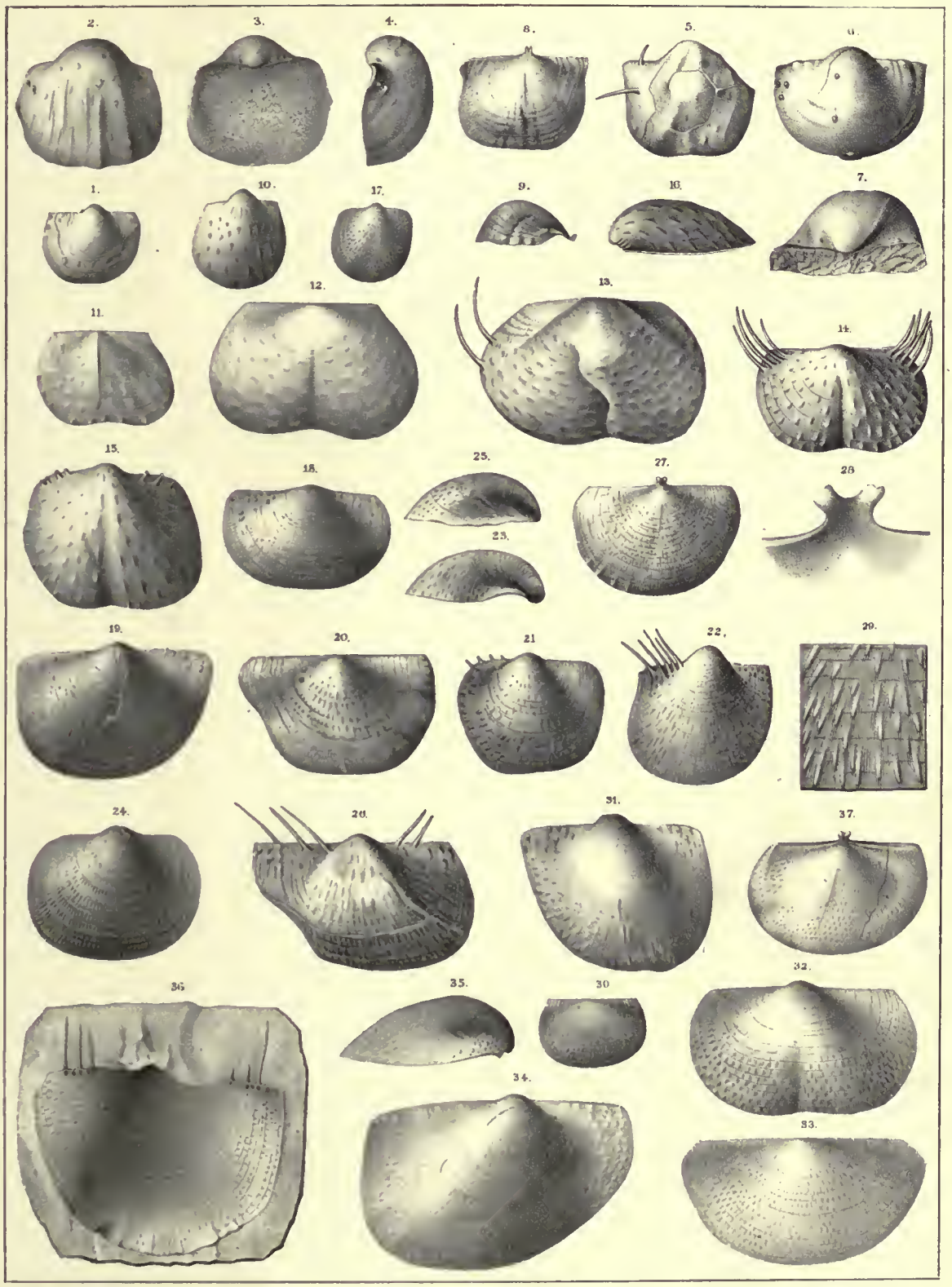

PLATE 25.

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Figs. 1 – 11. PRODUCTELLA SPECIOSA..... 175

1. An impression of the exterior of a dorsal valve, showing the marks of the cardinal process.
2. The interior of a dorsal valve.
3. A profile of specimen fig. 2.
4, 5. Views of ventral valves.
6, 7. Profiles of specimens figs. 5, 8.
8. A ventral valve which is broad and depressed and strongly pustulose.
9, 10, 11. Ventral, profile and cardinal views of a very gibbous individual—the specimen from which the original description was given.

Figs. 12, 13. PRODUCTELLA EXANTHEMATA..... 163

12, 13. The interiors of dorsal valves.

Figs. 14 – 21. PRODUCTELLA STRIATULA..... 177

14, 15. The interiors of dorsal valves.
16. A profile of specimen fig. 15.
17, 18. Ventral view and profile of a specimen of symmetrical form, showing scattered spine-bases.
19, 20, 21. Ventral and cardinal views and profile of a specimen of broader form—fig. 20, showing the muscular impressions.

Fig. 22. PRODUCTELLA ARCTIROSTRATA..... 182

22. An exfoliated interior of a dorsal valve, referred with doubt to this species.

Figs. 23 – 28. PRODUCTELLA LACHRYMOSA..... 172

23, 24. Impressions of dorsal valves, one with numerous pustules, and the other nearly destitute of pustules.
25, 26, 27. Ventral valves of this species; the figures 25 and 27 show some remains of spines and elongate pustules; 26 is a broader form with fewer pustules.
28. The ventral valve of a young individual of the same species, showing numerous elongate pustules.

Figs. 29 – 32. PRODUCTELLA LACHRYMOSA var. LIMA..... 174

29. A ventral valve which is regularly convex and showing short pustules.
30. A profile of the same.
31. A shorter and more quadrate form with a mesial depression; the pustules very symmetrically arranged. The specimen corresponds to the original description of *P. lima*, Conrad.
32. A cardinal view of the same specimen, showing the muscular markings and cavities left by the teeth.

Figs. 33 – 41. PRODUCTELLA LACHRYMOSA var. STIGMATA..... 174

33. An impression of a very large dorsal valve.
34. An impression of a more concave dorsal valve, showing the form of cardinal process.
35. A profile of the same.
36. An impression of a more symmetrical dorsal valve, showing regular and larger pustules, and also an impression of the cardinal process.
37. A very convex ventral valve, showing pits left by the spine-bases.
38. A cardinal view of the same.
39. A ventral valve preserving a greater number of spine-bases.
40. A profile of the same.
41. A cardinal view of the same, showing muscular impressions.

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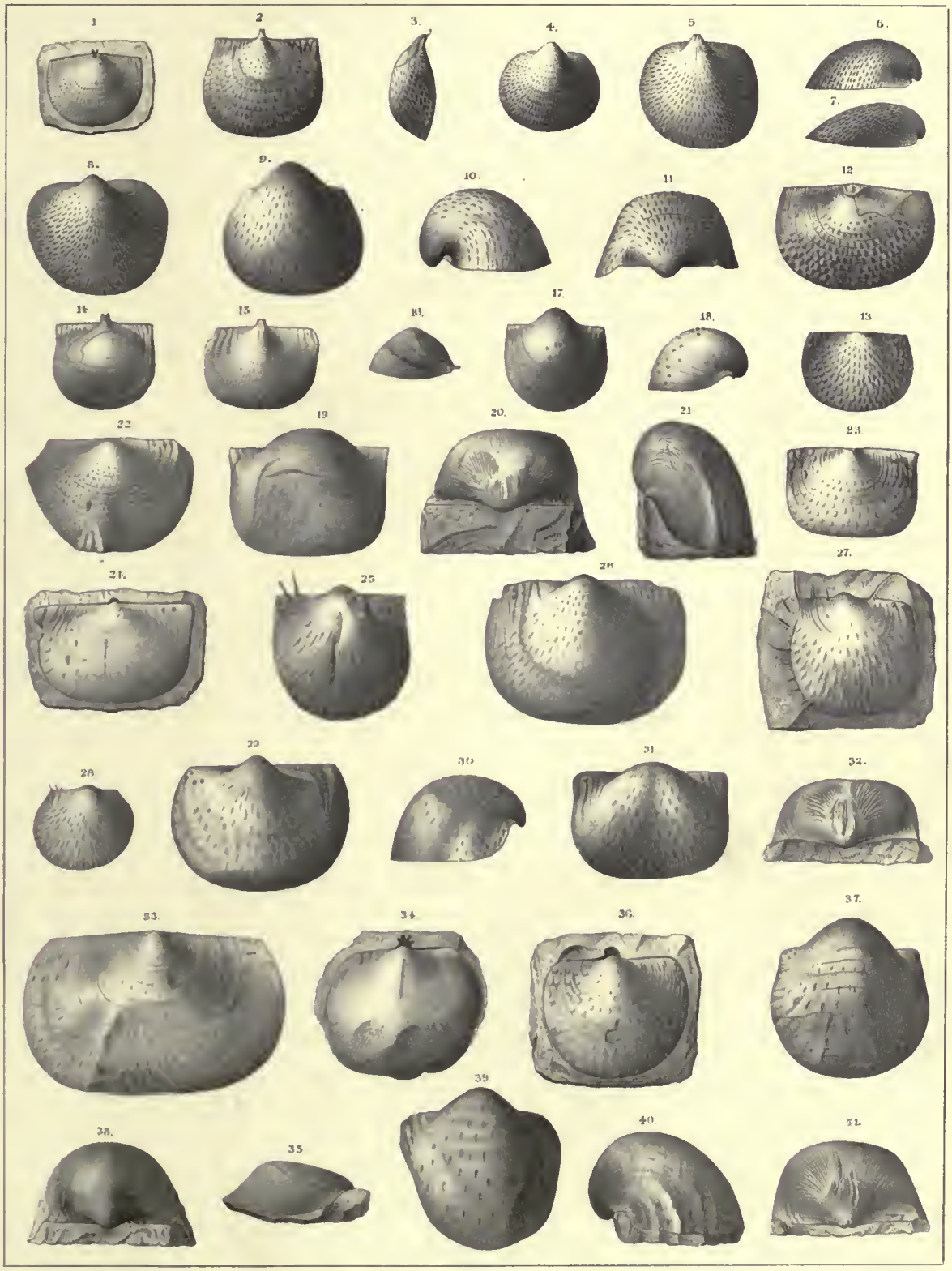

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PLATE 26.

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Figs. 1 – 8. PRODUCTELLA HYSTRICULA 178

1, 2. Impressions of dorsal valves, one of them showing the truncate apex, and both of them showing the marks of the narrow linear area.
3, 4, 5. Casts of ventral valves, the curved lines showing the relative convexity of the specimens.
6. A restored specimen, showing the spines as preserved in impressions in the sandstone.
7. The interior of a dorsal valve enlarged to two diameters, showing the form of the cardinal process and the small dental sockets.
8. A cardinal view of a cast of a ventral valve, showing the narrow area and bilobed apex; enlarged to two diameters.

Figs. 9 – 15. PRODUCTELLA COSTATULA 180

9. The interior of a dorsal valve, with an enlarged cardinal process from another individual.
10. A front view of the ventral valve of a narrow individual, showing elongate pustules at the bases of the spines, but with no continuous costæ.
11, 12. The front view, and profile of an older individual, showing continuous costæ.
13 – 15. Front view, profile, and cardinal view of another individual, showing continuous costæ.

Figs. 16 – 23. PRODUCTELLA ARCTIROSTRATA 182

16, 17. An impression of the exterior of a dorsal valve, with profile of the same.
18. The impression of a dorsal valve, showing strong concentric wrinkles, with an impression of the cardinal process; having fewer pustules on the surface than fig. 16.
19 – 21. Front, profile and cardinal views of a ventral valve, of the same variety of form and surface marking, as fig. 16.
22, 23. Two views of the typical specimen of this species; the ventral valve is distorted to some extent, but the mesial depression is apparently a natural feature.

Figs. 24 – 28. PRODUCTELLA BIALVEATA 183

24. A small specimen of a ventral valve, showing numerous concentric wrinkles, with a greater number of spines towards the front than usual in specimens of this species.
25. A young individual, with inconspicuous wrinkles, and a well defined mesial sinus.
26. A larger individual, which is nearly destitute of a sinus.
27. A larger individual, with distinct wrinkles and spine-bases on the cardinal margin, with a few similar marks on one side, in front; the mesial sinus is but faintly developed.
28. An imperfect specimen, with faint concentric wrinkles and numerous spiniferous tubercles near the front; the sinus is strongly developed.

Figs. 29 – 42. PRODUCTELLA ONUSTA 184

29. The interior of the dorsal valve of a young individual, showing the cardinal process and socket ridges.
30. The interior of a large dorsal valve, showing concentric wrinkles, the cardinal process and median septum, with the muscular and vascular impressions.
31. The interior of a dorsal valve from which the shell is partially exfoliated; the cardinal process is much stronger than in fig. 30.
32. A cardinal view of the specimen fig. 31, showing the convexity of the inner surface.
33. A fragment of a large dorsal valve, showing the termination of the reniform vascular impression on one side, with an oblique vascular impression diverging on each side from the termination of the mesial septum. The outline is restored to show the relation of the parts preserved.
34. A dorsal valve which has been doubtfully referred to this species; it is nearly flat, with a few obscure wrinkles, and a cardinal process similar to others of this species.
35. The ventral valve of a young individual.
36, 37, 38. Ventral and cardinal views, and profile of a large ventral valve of this species.
39, 40. Cardinal views of casts of two ventral valves, showing the muscular markings, and in 39, the deep pits on the sides of the beak left by the removal of the dental lamellæ.
41. An enlargement of the surface of the shell, showing round spine-bases, and irregular lines of growth.
42. An enlargement of the surface of the cast of a ventral valve, showing the irregular striation and distant puncta.

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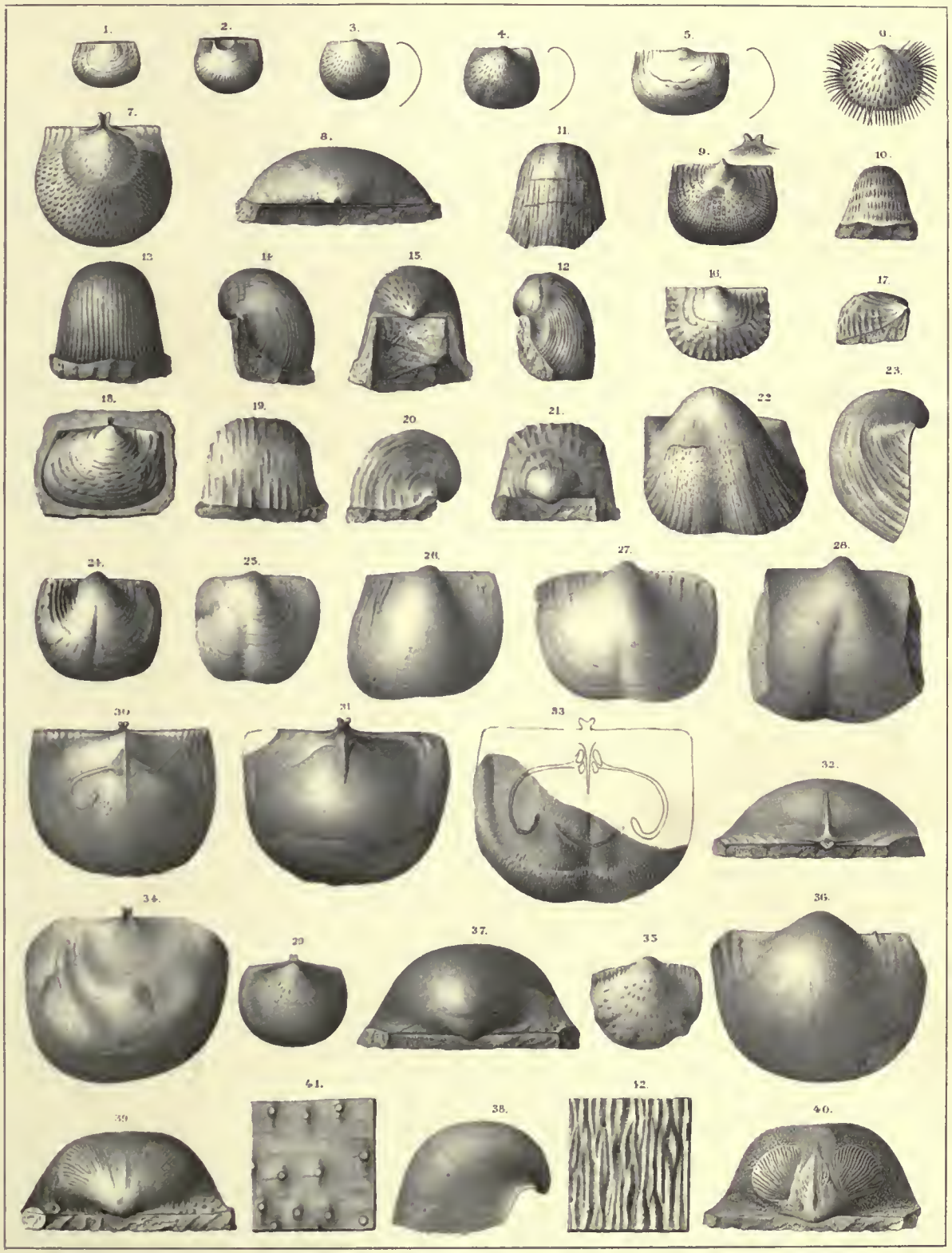

PLATE 27.

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Figs. 1 – 4. CYRTINA HAMILTONENSIS..... 2

1, 2. Views of casts of a dorsal and a ventral valve, from the Schoharie grit, the latter showing the line of the medium septum.

3, 4. Front and cardinal views of a ventral valve from the Corniferous limestone, the latter view showing the covered deltidium.

Figs. 5 – 10. CYRTINA BIPLICATA..... 266

5, 6, 7. Dorsal, cardinal and front views of an individual of this species, from the Schoharie grit.

8. A ventral valve of a specimen from Michigan.

9, 10. Ventral and cardinal views of the original specimen of this species.

Figf. 11 – 12. CYRTINA CRASSA..... 267

11, 12. Dorsal and ventral views of a specimen of this species from the Corniferous limestone.

Figs. 13 – 16. SPIRIFERA DUODENARIA..... 189

13. A young individual, which is a partial cast.

14. A ventral valve of this species.

15. The cast of a dorsal valve.

16. The cast of a ventral valve. These specimens are all from the Schoharie grit.

Figs. 17 – 28. SPIRIFERA MACRA..... 190

17. A young individual of this species.

18. A full grown specimen retaining the shell. The extremities are restored from other specimens.

19, 20, 21. Dorsal, cardinal and profile views of a specimen retaining a portion of the shell.

22. A cast of a large dorsal valve.

23. A cast of a ventral valve.

24. A cardinal view of a cast of the ventral valve.

25. The cast of a ventral valve of a small individual of this species. ?

26, 27. Dorsal and ventral views of an individual which is less extended on the hinge line than the usual form. The specimen is somewhat weathered.

28. Profile of the above.

Fig. 29. SPIRIFERA GRIERI..... 194

29. A dorsal view of a crushed specimen, from the Schoharie grit.

Figs. 30 – 34. SPIRIFERA RARICOSTA..... 192

30. The ventral valve of an exfoliated shell.

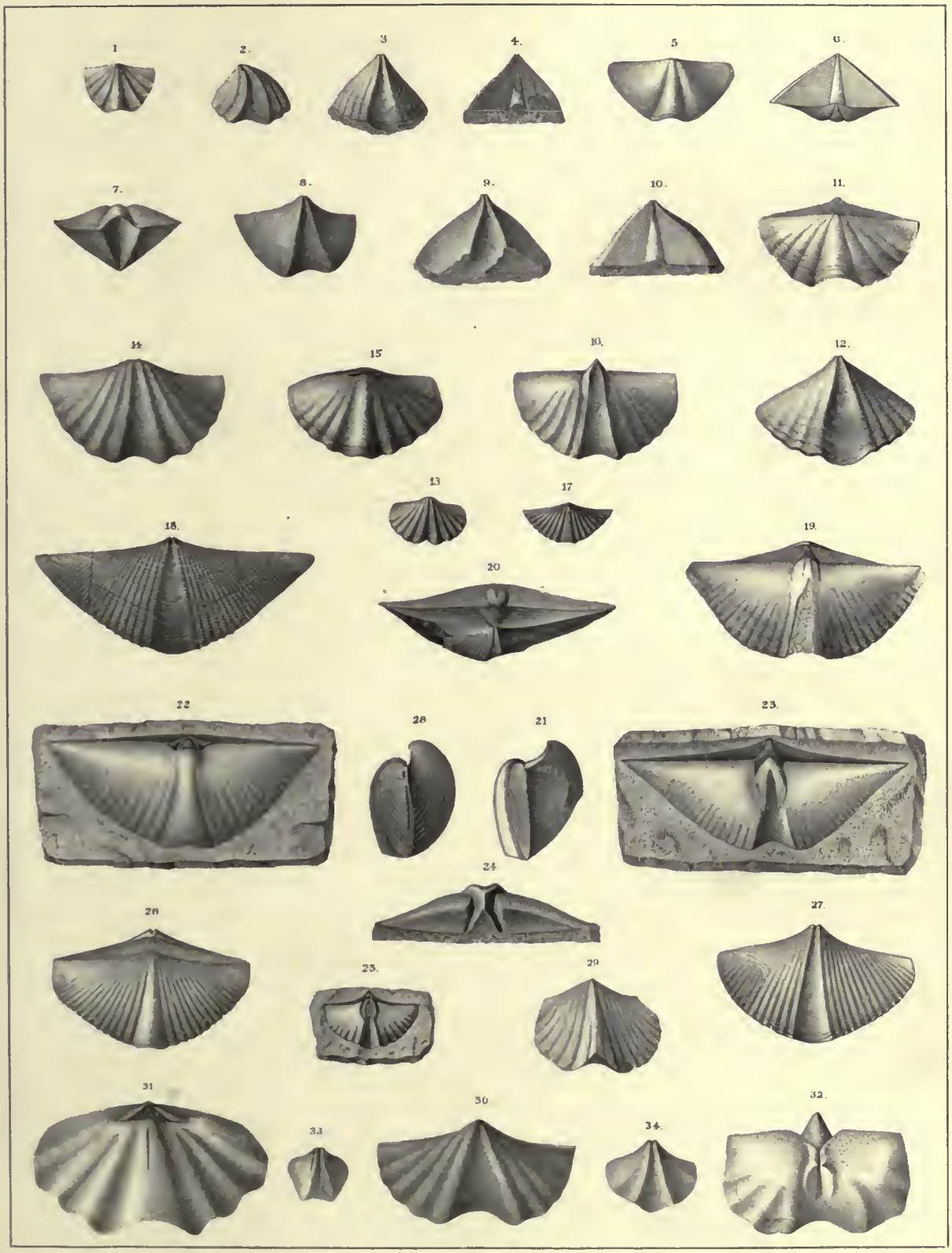
31. The cast of a dorsal valve, showing the teeth sockets and median septum.

32. The cast of a ventral valve, showing the muscular impressions, central septum, and filling of the rostral cavity.

33, 34. Ventral views of two young specimens, referred with doubt to this species.

Schoharie Grit and Corniferous Limestone

(BRACHIOPODA.)



R P Whitfield Jet

Swinton, Lith.

PLATE 28.

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Figs. 1 – 11. SPIRIFERA GREGARIA 195

1. Dorsal view of a young individual.
2. A dorsal view of a specimen of the ordinary size and form.
3 – 6. Ventral, dorsal, profile and front views, of a large and gibbous form.
7, 8. Interiors of ventral valves. These specimens are from the Falls of the Ohio.
9, 10. Dorsal and cardinal views of a cast of this species in chert, from Indiana. This specimen shows a distinct depression in the mesial fold which is not a usual feature.
11. The interior of a ventral valve and part of a dorsal, showing the crura and the last turns of the spire. From the Falls of the Ohio.

Figs. 12 – 16. SPIRIFERA FORMOSA..... 220

12 – 16 Dorsal, cardinal, profile, front and ventral views of the typical specimen of the species.

Figs. 17 – 23. SPIRIFERA GRIERI..... 194

17 – 20. Four views of a specimen of small or medium size.
21. A dorsal view of a large specimen, showing several plications on the mesial fold.
22 A ventral valve, where the hinge is much extended, and the plications are less defined in the mesial depression.
23. A front view of the specimen fig. 21.

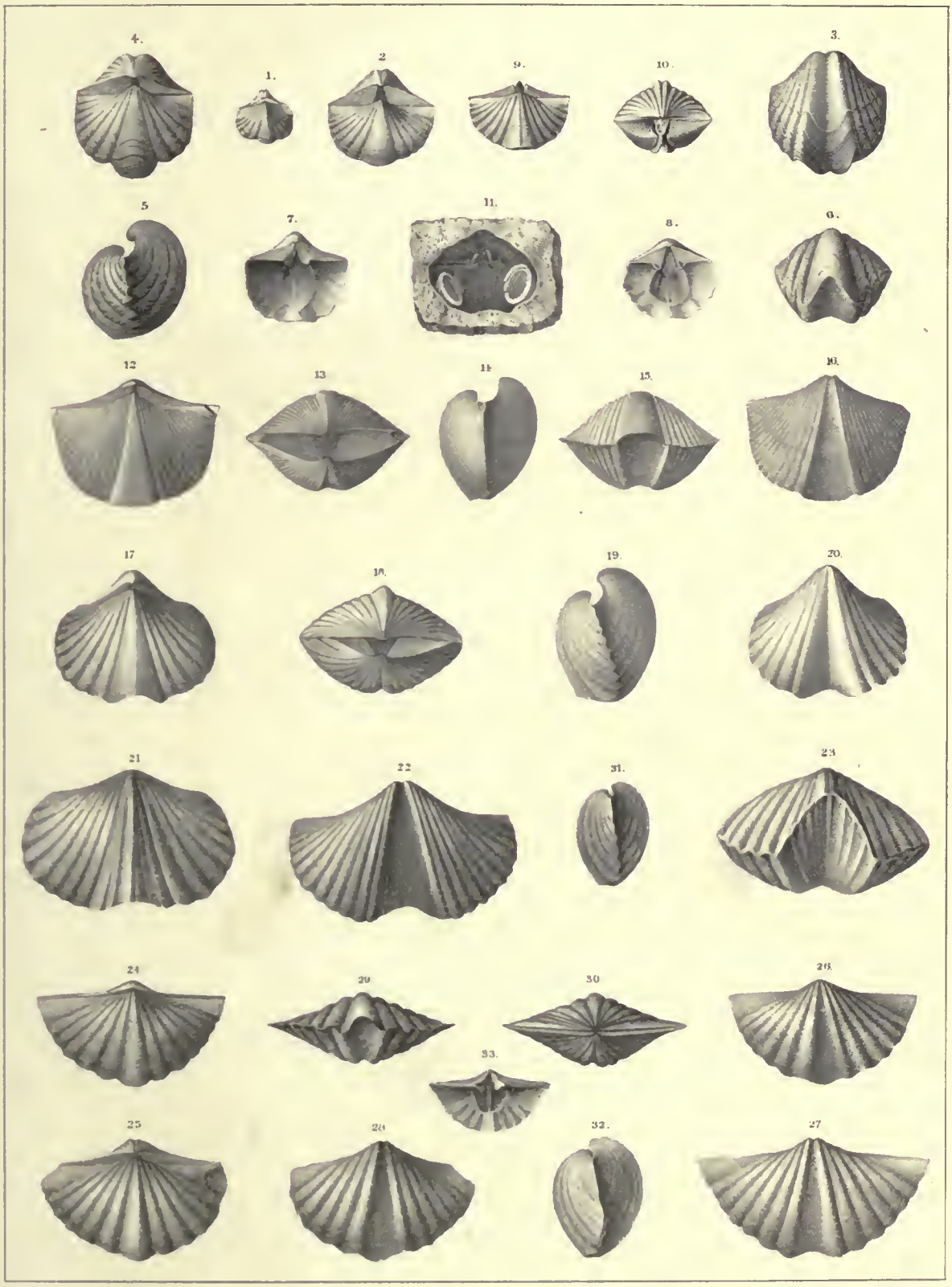
In the collections of the Canadian Geological Survey, there is a specimen of this species of much larger size than those observed or figured among the New York collections.

Figs. 24 – 33. SPIRIFERA DUODENARIA..... 189

24, 26, 29, 30, 31. Dorsal, ventral, front, cardinal and profile views of a well formed and characteristic specimen of medium size.
25, 28, 32. Dorsal, ventral and profile views of a more gibbous form.
27. Ventral view of a large individual.
33. The interior of a small ventral valve.

Corniferous Limestone

(BRACHIOPODA.)



R. P. Whitfield del

Swinton, lith.

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Figs. 1 – 8. SPIRIFERA OWENI..... 197

1. Dorsal view of a young specimen.
2. Dorsal view of a larger individual.
3 – 7. Dorsal, ventral, cardinal, profile and front views of a specimen of ordinary size and characteristic form.
8. Interior of a part of a ventral valve.

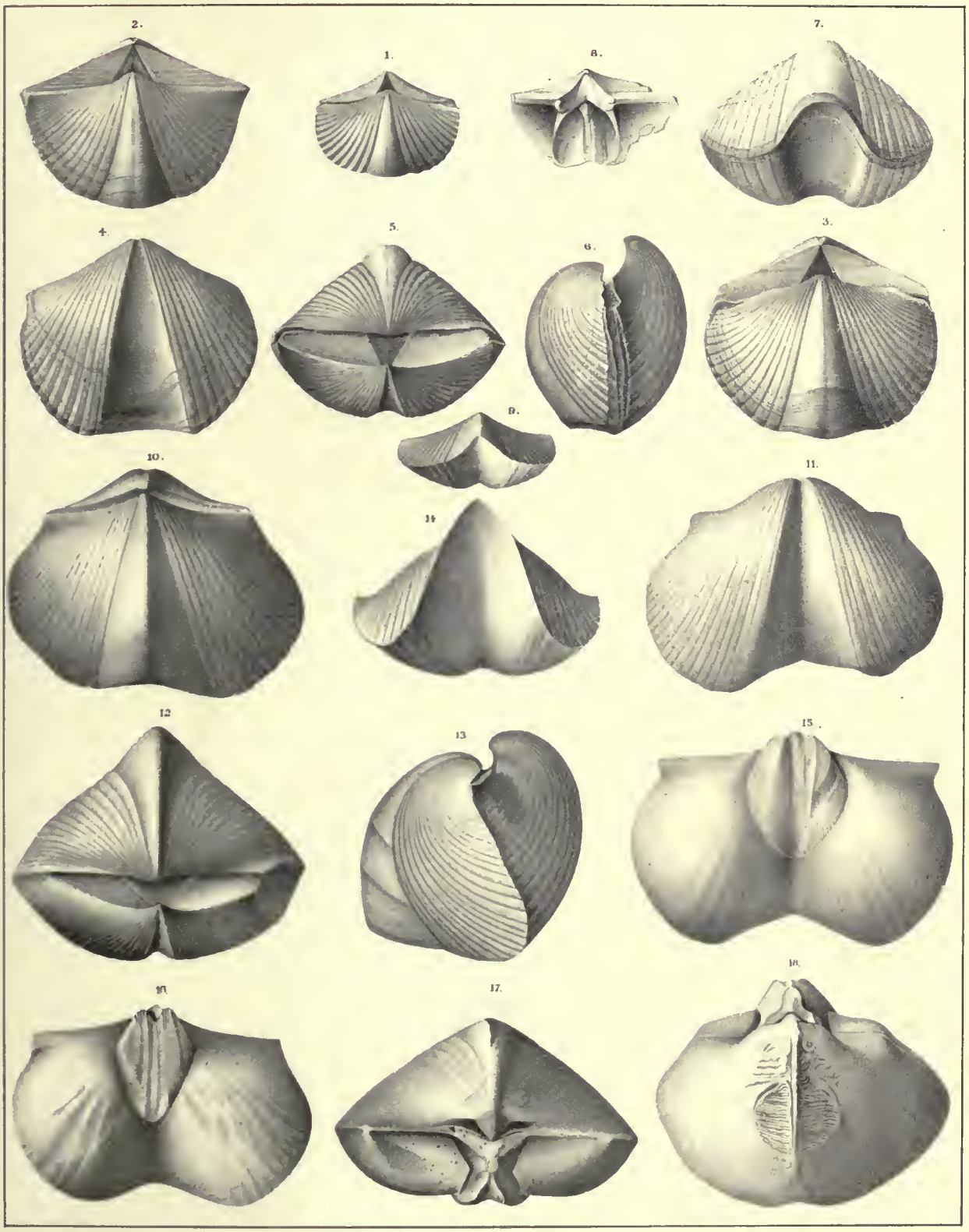
Fig. 9 – 18. SPIRIFERA ACUMINATA..... 198

9. Front view of a young individual, from New York.
10 – 13. Dorsal, ventral, cardinal and profile views of a specimen of ordinary size and form, from near Sandusky, Ohio.
14. Front view of a small but extremely elevated specimen, from Williamsville, N. Y.
15. Cast of a ventral valve, showing the muscular impression of greater width than usual; from Albany county, New York.
16, 17. Ventral and cardinal views of a cast in chert, from Camp Creek, Ind., showing muscular impressions, dental cavities, etc. The mesial elevation has been injured by weathering, and the outline shows the probable extent of the elevation.
18. Dorsal view of a specimen from the same locality as the preceding, showing the peculiar muscular markings of the dorsal valve.

UPPER HELDERBERG GROUP.

Corniferous Limestone.

(BRACHIOPODA.)



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Swinton, lith.

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Figs. 1 – 9. SPIRIFERA RARICOSTA..... 192

1. A dorsal view of a young specimen.
2. A dorsal view of a larger individual preserving a portion of the shell.
3 – 6. Dorsal, ventral, profile and front views of a specimen which is very short upon the hinge line and of very gibbous form, with less than the usual number of plications.
7. A ventral valve which is very much extended on the hinge line, presenting much the appearance of *S. perlamellosa*.
8. A front view of a specimen, showing the elevation of the fold.
9. The interior of a ventral valve which is much rounded on the cardinal extremities.

Figs. 10 – 15. SPIRIFERA DISPARILIS..... 204

Compare with *S. pyxadatus*, of the Oriskany sandstone.

10 – 12, 14. Dorsal, ventral, profile and front views of a specimen of ordinary character.
13. Cardinal view of another individual, showing the area and foramen.
15. Dorsal view of a larger specimen, showing stronger lateral plications. The figures are all enlarged to two diameters.

Figs. 16 – 20. SPIRIFERA MACROTHYRIS..... 202

16. Dorsal view of a large specimen showing the area and foramen of the ventral valve. The shell is almost entirely removed, leaving a partial cast on the dorsal side.
17. A large imperfect ventral valve.
18. A cardinal view of another specimen, showing the foramen and the striated cardinal area.
19. Cardinal view of a young individual, showing a more elevated and sharper mesial fold.
20. A partial cast of the ventral valve, showing the filling of the large muscular imprint.

Fig. 21. SPIRIFERA UNICA..... 203

21. An imperfect ventral valve. There is a strong probability that this is identical with *S. arenosa*, of the Oriskany sandstone.

Corniferous Limestone

(BRACHIOPODA)

R.P Whitfield ,del

Swinton, lith.

PLATE 31.

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Figs. 1–4 SPIRIFERA VARICOSA 205

1, 3, 4. Dorsal, ventral and cardinal views of a specimen of the ordinary size and form of those from the Falls of the Ohio.

2. Dorsal view of another individual, showing a more strongly rugose surface. From the same locality as the preceding.

Fig. 23. SPIRIFERA VARICOSA var. 206

23. A ventral valve with the hinge line much extended, from Western New York.

Figs. 5–8. SPIRIFERA SEGMENTA 207

5–8. Dorsal, ventral, cardinal and profile views of the original specimen of this species, from the Falls of the Ohio.

Figs. 9, 10. SPIRIFERA ARCTISEGMENTA 208

9, 10. Dorsal and cardinal views of the original specimen.

Figs. 11–13. SPIRIFERA EURUTEINES var. FORNACULA 211

11–13. Dorsal, ventral and cardinal views of a specimen from Bake-oven, Illinois.

Figs. 14–19. SPIRIFERA EURUTEINES 209

14–17. Ventral, cardinal, profile and dorsal views of a specimen of ordinary size and form.

18. The interior of a ventral valve containing the spires, which are covered with chalcedony.

19. A cardinal view of a young individual.

Figs. 20–22, 24–30. SPIRIFERA MANNI 211

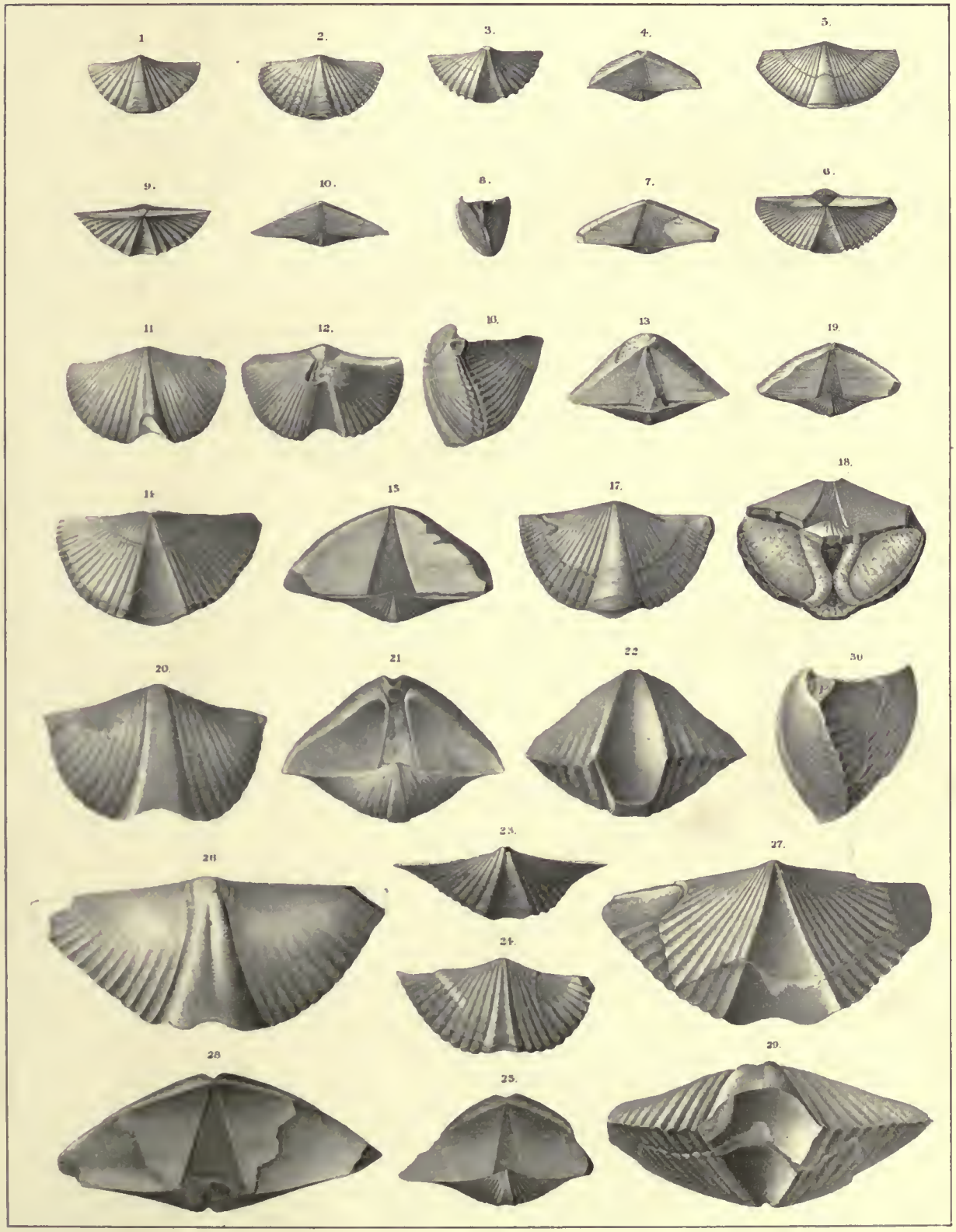
20–22. Dorsal, cardinal, and front views of a characteristic specimen, from near Sandusky, Ohio.

24, 25. Dorsal and cardinal views of an imperfect specimen, from Williamsville, New York.

26–30. Dorsal, ventral, cardinal, front and profile views of a large imperfect specimen from N. York, which is much more extended laterally than the usual form.

Corniferous Limestone.

(BRACHIOPODA.)



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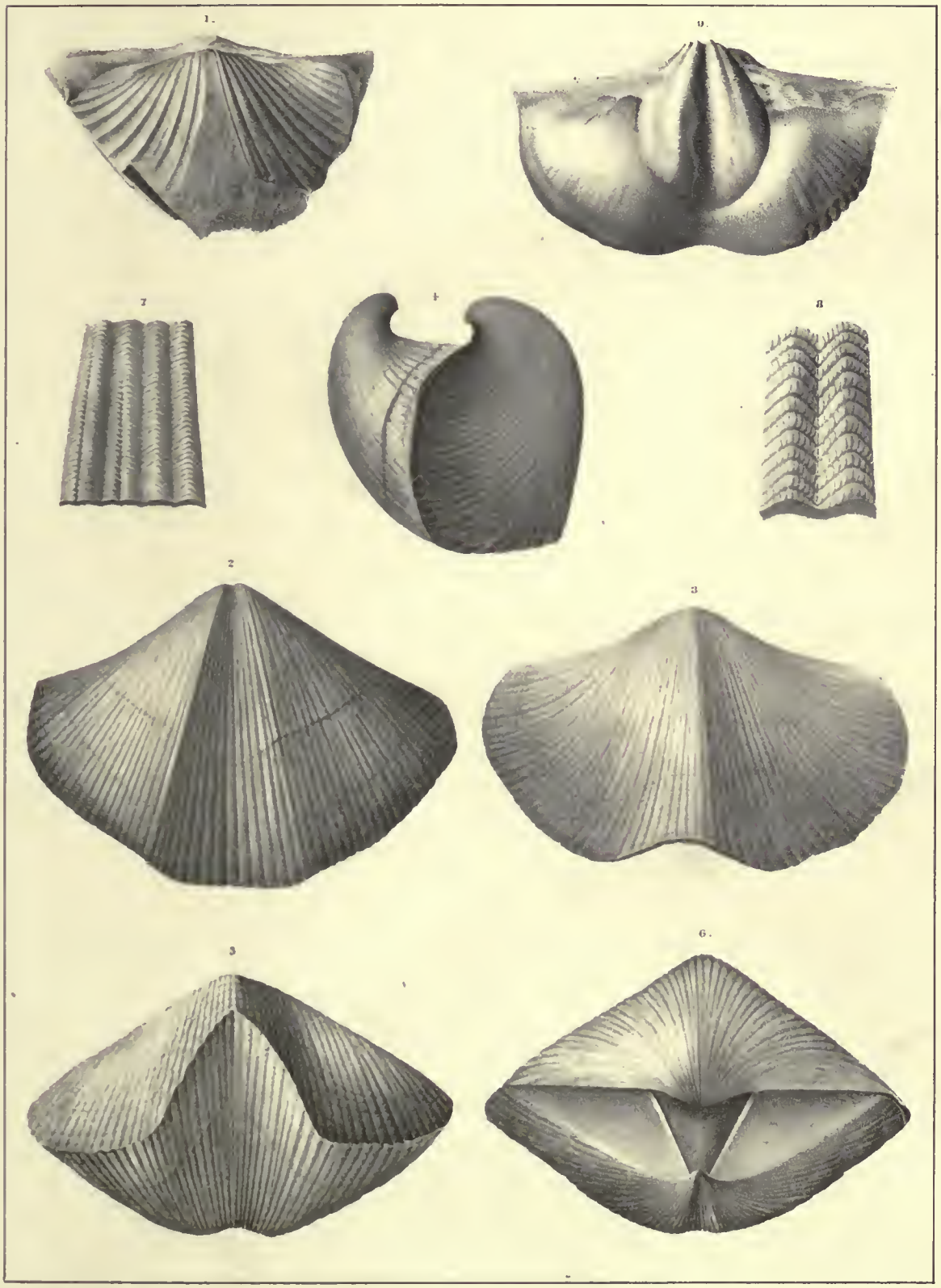
Figs. 1 – 9. SPIRIFERA DIVARICATA 213

1. An imperfect dorsal valve of this species. From the Corniferous limestone.
2 – 6. Ventral, dorsal, profile, front and cardinal views of a large and very perfect specimen, from the shales of the Hamilton group.
7. An enlargement of the surface, showing the bifurcating plications and the concentric striæ.
8. Still further enlargement, showing the rugose character of the concentric striæ.
9. The cast of a ventral valve, from the Corniferous limestone.

(BRACHIOPODA.)



R.P. Whitfield, del. Swinton, lith.

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Figs. 1 – 21. SPIRIFERA FIMBRIATA 214

1. An imperfect dorsal valve of this species, from the Oriskany sandstone.
2. A view of an imperfect ventral valve of this species.
3. The cast of a ventral valve, showing the muscular impression.
4. A view of a cast of a dorsal valve. This, and the two preceding figures, are from specimens found in the Scholharie grit.
5. 6. Dorsal and ventral views of a small individual, from the Corniferous limestone.
7. A dorsal view of an individual of medium size, from the Corniferous limestone.
8 – 11. Profile, dorsal, ventral and front views of a full grown individual, from the Corniferous limestone.
12, 13. Dorsal and ventral views of a small individual.
14. Cardinal view of a short individual of this species.
15. A ventral view of another specimen which preserves the fine setiform spires of the surface.
16 – 19. Profile, front, dorsal and ventral views of a large sized specimen. Figures 12 – 19 are from specimens from the soft shales of the Hamilton group.
20. A cardinal view of a cast of this species, from the Hamilton group, Hardy county, Va.
21. Enlargement of the surface of specimen fig. 18, showing the pustulose markings.

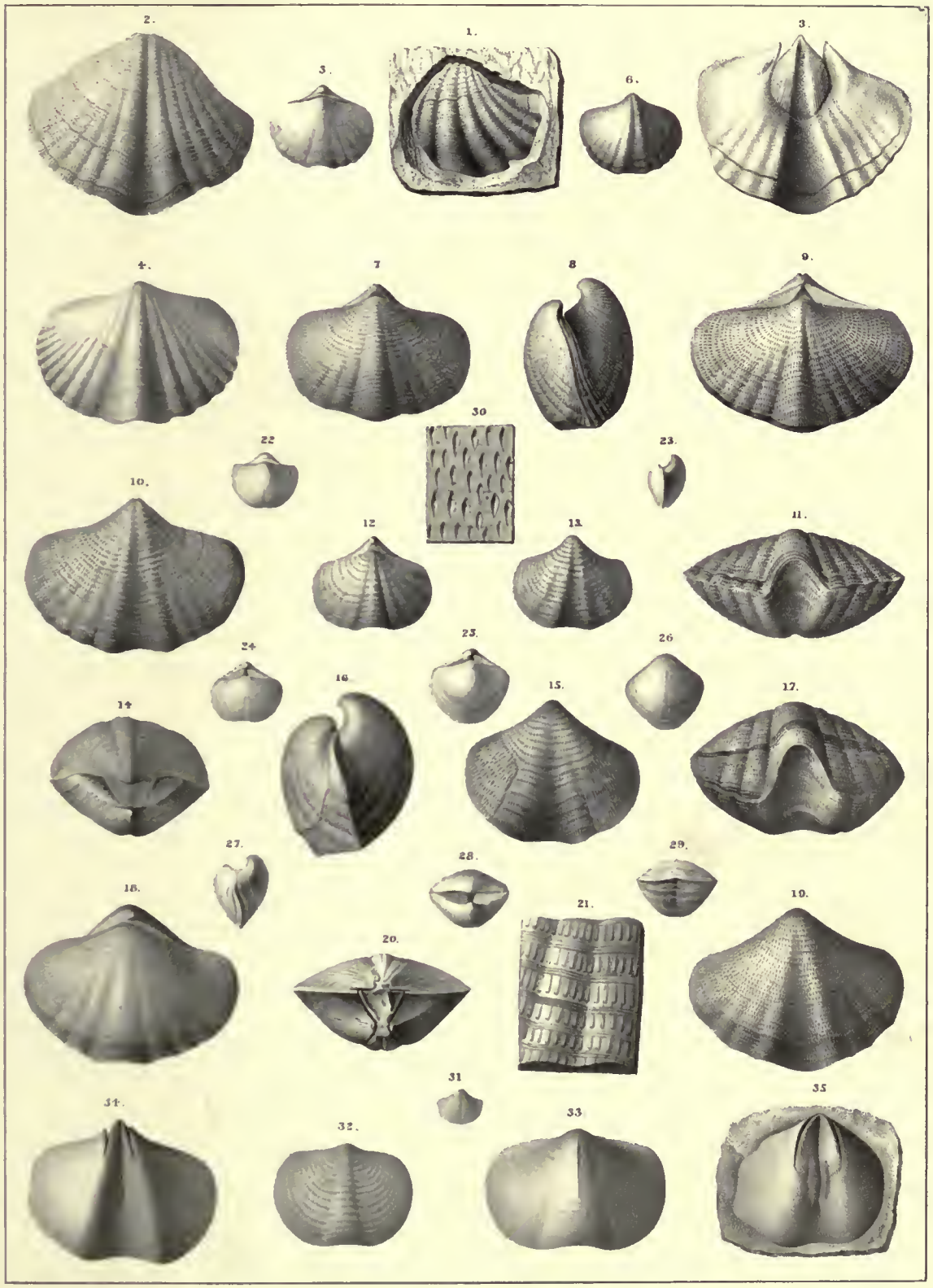
Figs. 22 – 30. SPIRIFERA SUBUMBONA 234

22, 23. Dorsal and profile views of a specimen of this species.
24. Dorsal view of another individual.
25 – 29. Dorsal, ventral, profile, cardinal and front views of a large and rather gibbous specimen.
30. Enlargement of the surface, showing the small pits that result from a partial exfoliation of the shell. These figures are from specimens occurring in the limestones of the Marcellus shales.

Figs. 31 – 35. SPIRIFERA PRÆMATURA..... 250

31. A ventral valve of a small individual.
32. A larger dorsal valve, showing the pustules of the surface. This, and the preceding figure are from New York specimens.
33. Cast of another dorsal valve, showing the impression of the median septum.
34. View of the cast of a ventral valve.
35. Cast of ventral valve of another individual, having a much larger rostral cavity. This, and the two preceding figures, are from specimens occurring near Meadville, Pa.

(BRACHIOPODA.)



R.P. Whitfield, del.

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Figs. 1 – 23. SPIRIFERA MUCRONATA..... 216

1, 2, 4. Dorsal valves, showing variations in the extension of the cardinal extremity.

3. Ventral valve of a specimen from the Marcellus shales, very much extended on the hinge line.

5, 6, 7. Dorsal, ventral and profile views of a specimen of medium size and ordinary form.

8. Dorsal view of a specimen in which the hinge line is not extended.

9. Dorsal view of a specimen which is extended on the hinge-line, so as to give a triangular form to the shell.

10. Dorsal view of an individual, having a semicircular outline.

11. Ventral view of a large and well preserved individual of ordinary form, showing a deeply impressed line on the mesial fold, with a corresponding plication in the sinus.

12. Dorsal view of the above.

13. Profile of the same.

14. Cardinal view of the same.

15. Ventral view of a specimen where the hinge-line is considerably extended.

16. Dorsal view of a specimen from the arenaceous shales, in which the cardinal extremities are greatly extended.

17. Ventral view of another specimen of the same character.

18. Front view of a specimen of ordinary form.

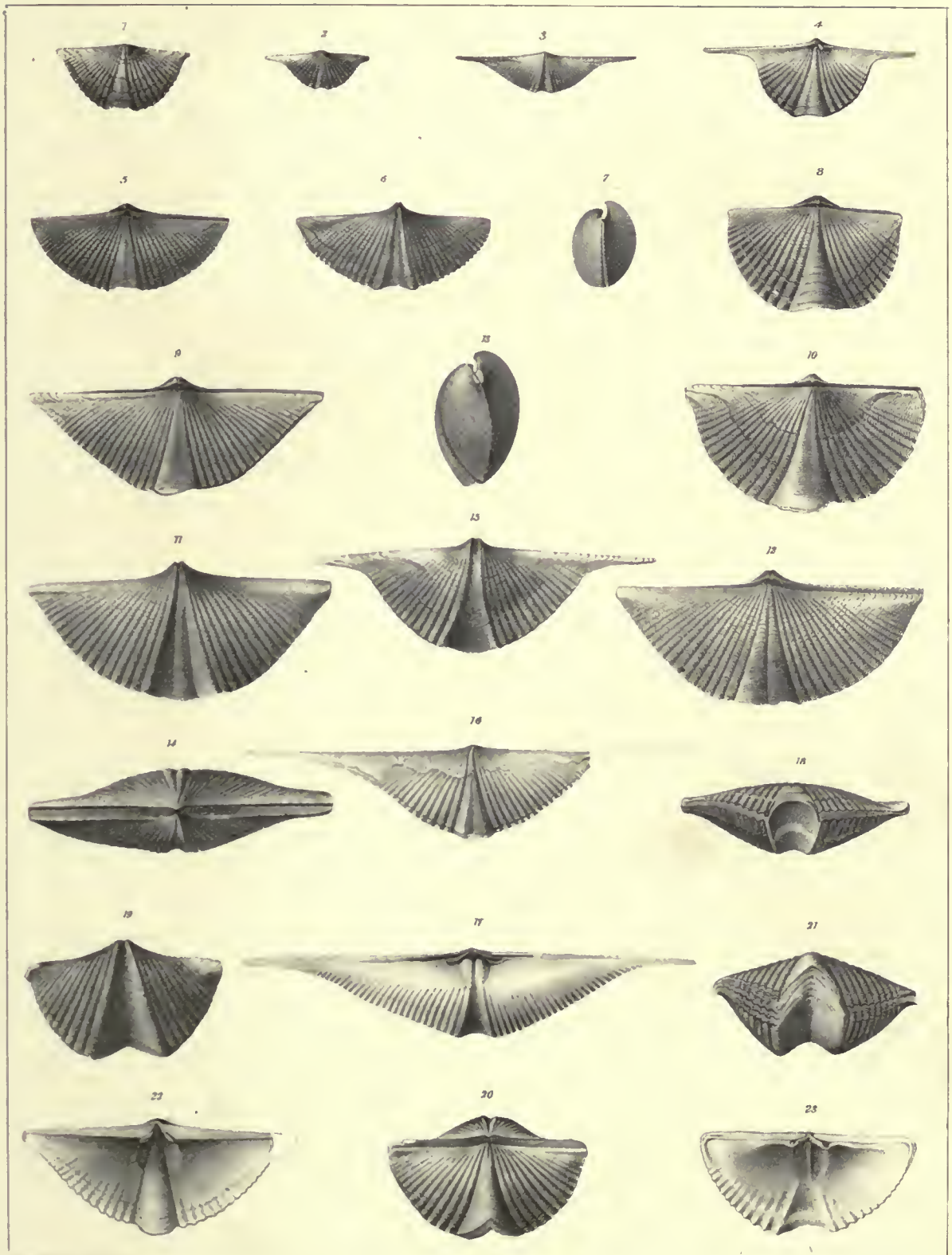
19. Ventral view of a short gibbous form with an angular mesial fold and sinus. This form approaches in character, *S. ziczac.*

20. Dorsal view of same.

21. Front view of same.

22. Interior of ventral valve.

23. Interior of dorsal valve.



Bowen & Co. lith. Philada.

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Figs. 1 – 9. SPIRIFERA TULLIA 218

1 – 3. Views of dorsal valves, one of them showing rugose markings on the plications.
4. A ventral valve of the ordinary form.
5. Cardinal view of a ventral valve, showing area and foramen.
6. View of a ventral valve, having the cardinal extremities unusually extended.
7, 8, 9. Casts of ventral valves of this species, showing great variations in the rostral portions of the shell.

Figs. 10 – 14. SPIRIFERA SCULPTILIS 221

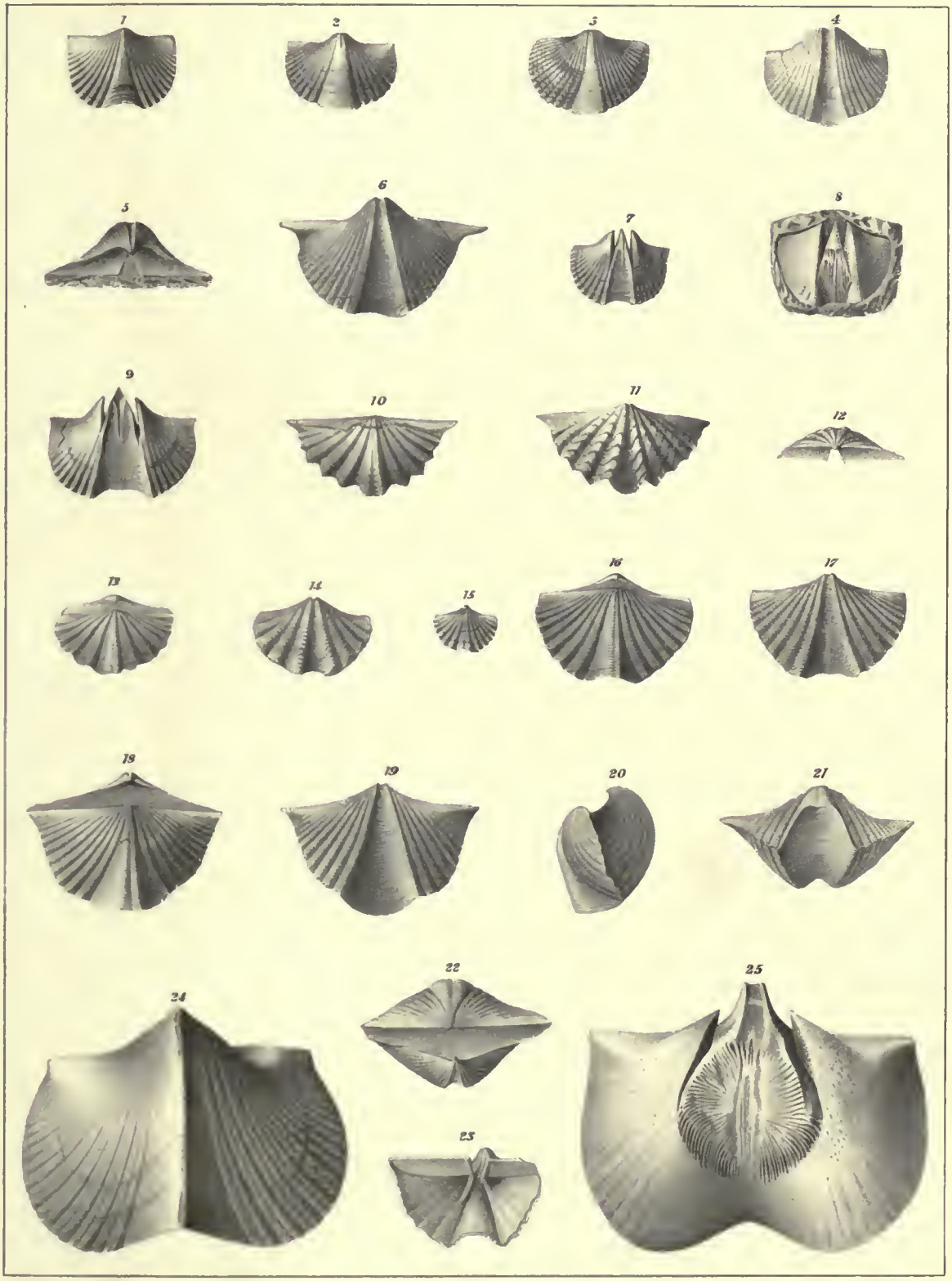
10. Dorsal valve of this species, from which the shell is partly exfoliated.
11. View of the ventral valve, showing the strong concentric ridges.
12. Cardinal view of the ventral valve, showing area and foramen.
13, 14. Dorsal and ventral views of a specimen, which is with doubt, referred to this species— the concentric ridges being more closely arranged and finer than in the preceding figures.

Figs. 15 – 23. SPIRIFERA ZICZAC 222

15. Dorsal view of a small individual.
16, 17. Dorsal and ventral views of an individual of ordinary size.
18 – 22. Dorsal, ventral, profile, front and cardinal views of a large and well preserved individual.
23. Interior of ventral valve, showing the extension of the dental lamellæ into the body of the shell.

Figs. 24, 25. SPIRIFERA ACUMINATA 234

24. Dorsal valve of this species, showing the bifurcating plications and the angular mesial fold.
25. Cast of a ventral valve, showing the strongly marked muscular impression and the filling of the rostral portions of the shell.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Figs. 1 – 13. SPIRIFERA GRANULIFERA 223

1. Dorsal view of a small individual.
2. Cardinal view of the same, showing great height of area.
3. Profile of same.
4. Ventral view of another specimen, showing an angular mesial sinus.
5. Ventral view of a well preserved and perfect specimen of the ordinary size.
6. Dorsal view of the same.
7. Profile of same, for comparison with fig. 3.
8. Front view of same.
9. Cardinal view of the same.
10. Dorsal view of a larger and less gibbous specimen, showing more of the ventral area.
11. View of the interior of a dorsal valve, showing the muscular impressions, area and dental sockets.
12. View of the interior of a ventral valve, showing the muscular impression, cardinal area, and the callosity within the apex of the foramen.
13. Enlargement of a part of two plications, showing the granulose structure of the surface.

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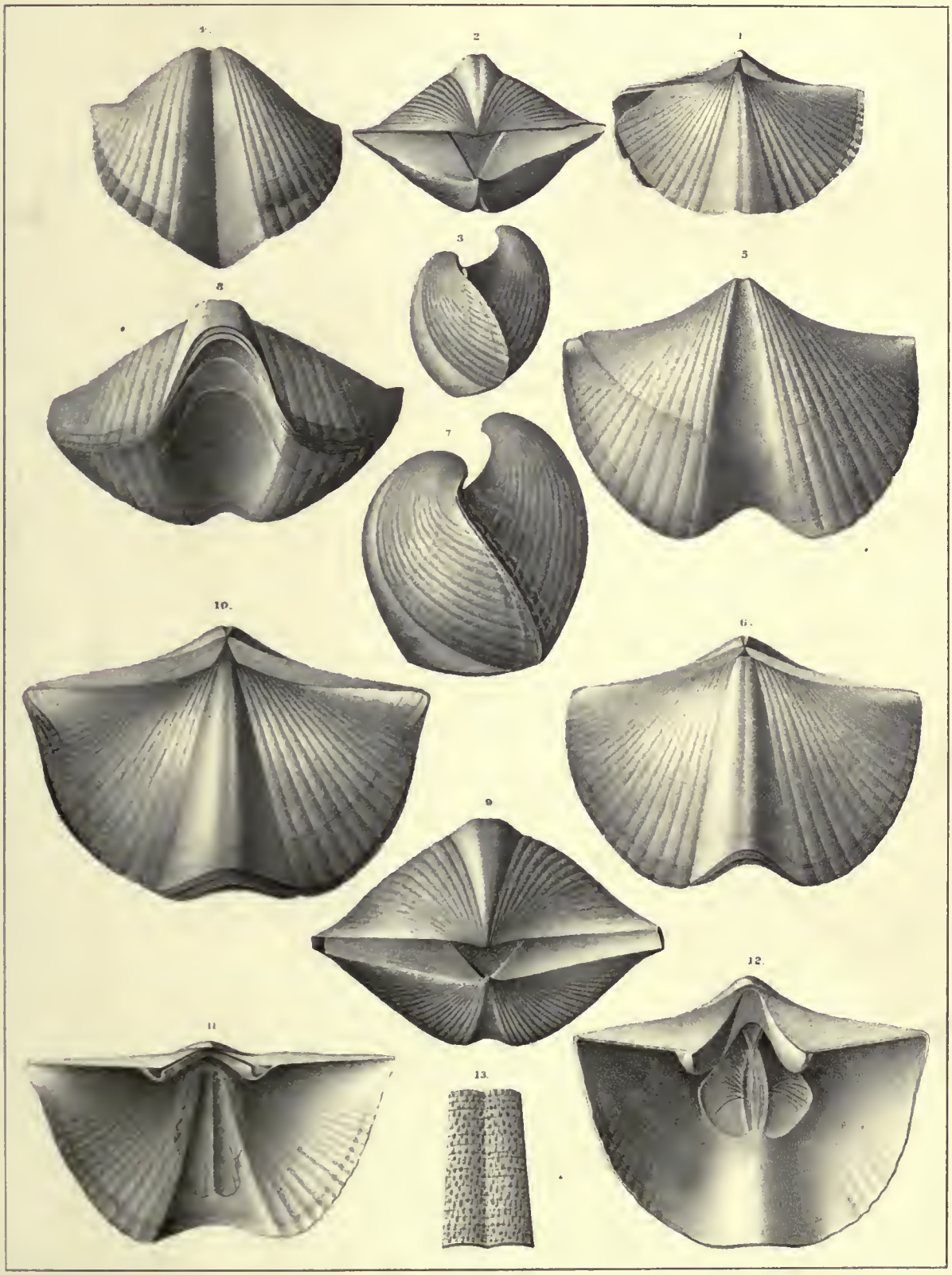

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Figs. 1–4. SPIRIFERA GRANULIFERA var. CLINTONI..... 223

1. Dorsal view of a small individual.
2. Ventral view of the same.
3. Profile of the same.
4. Ventral view of a much larger specimen.

Fig. 9. SPIRIFERA MEDIALIS ? 227

9. Dorsal view of a young specimen, doubtfully referred to this species.

Figs. 10–20. SPIRIFERA MARCYI 226

10. Dorsal view of a small individual of this species.
11. Ventral view of the same.
12. Cardinal view of the same.
13. Dorsal view of an unsymmetrical specimen of gibbous form, showing the area and foramen.
14. View of a ventral valve of another individual.
15. Ventral view of a more extended form. The front of the shell is shortened by crushing.
16. Profile view of specimen fig. 13, showing the great rotundity of the dorsal valve.
17. Interior of a dorsal valve, showing the cardinal process and dental sockets.
18. Enlargement of surface, showing the elongated pustulose markings characteristic of this species.
19. Cardinal view of an individual, which is imperfect at the extremities. The valves are less gibbous than in fig. 16.
20. Interior of an imperfect ventral valve, showing the broad muscular impression.

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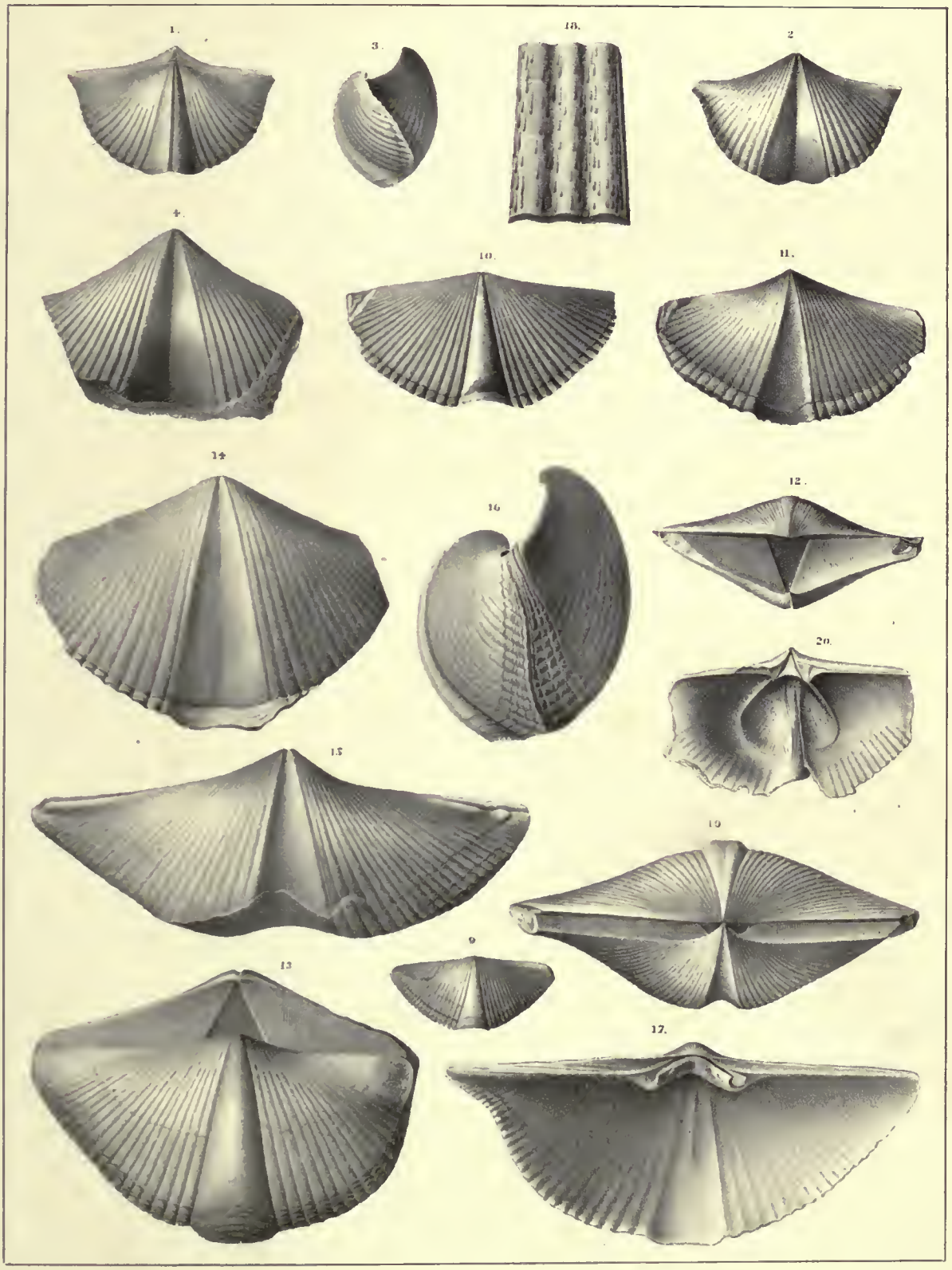

R P Whitfield, del

Swinton. lith

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Figs. 1 – 25. SPIRIFERA MEDIALIS 227

1. Dorsal view of a small and very symmetrical specimen.
2, 3. Dorsal and cardinal views of a larger specimen, having the extremities of the hinge line extended; fig. 3, shows the cardinal area and foramen.
4 – 6. Dorsal, cardinal and profile views of a more ventricose specimen, with a narrow incurved area and strong concentric lines of growth.
7, 8. Dorsal and cardinal views of a specimen of medium size, having a higher area, which is but slightly incurved.
9 – 11. Dorsal, profile and ventral views of a specimen having a high area and a semicircular dorsal valve.
12, 13. Dorsal and cardinal views of a specimen of slightly unsymmetrical form and rather strong ribs.
14 – 16. Dorsal, front and ventral views of a large specimen, having a small area and slightly projecting ventral beak.
17 – 20. Dorsal, ventral, front and profile views of another specimen corresponding in size with the last, but having a higher area, more projecting ventral beak, and higher mesial fold, presenting a strong contrast between figs. 17 and 14, and between 19 and 15.
21, 22. Cardinal views of two individuals with high areas, showing considerable variation in the proportions of the deltidium; contrasting strongly in these respects with fig. 13.
23, 24. Interiors of dorsal valves, showing the muscular impressions, socket plates, etc.
25. Interior of a ventral valve, showing the muscular impression, cardinal area, teeth, and the callosity filling the apical portion of the deltidial opening.

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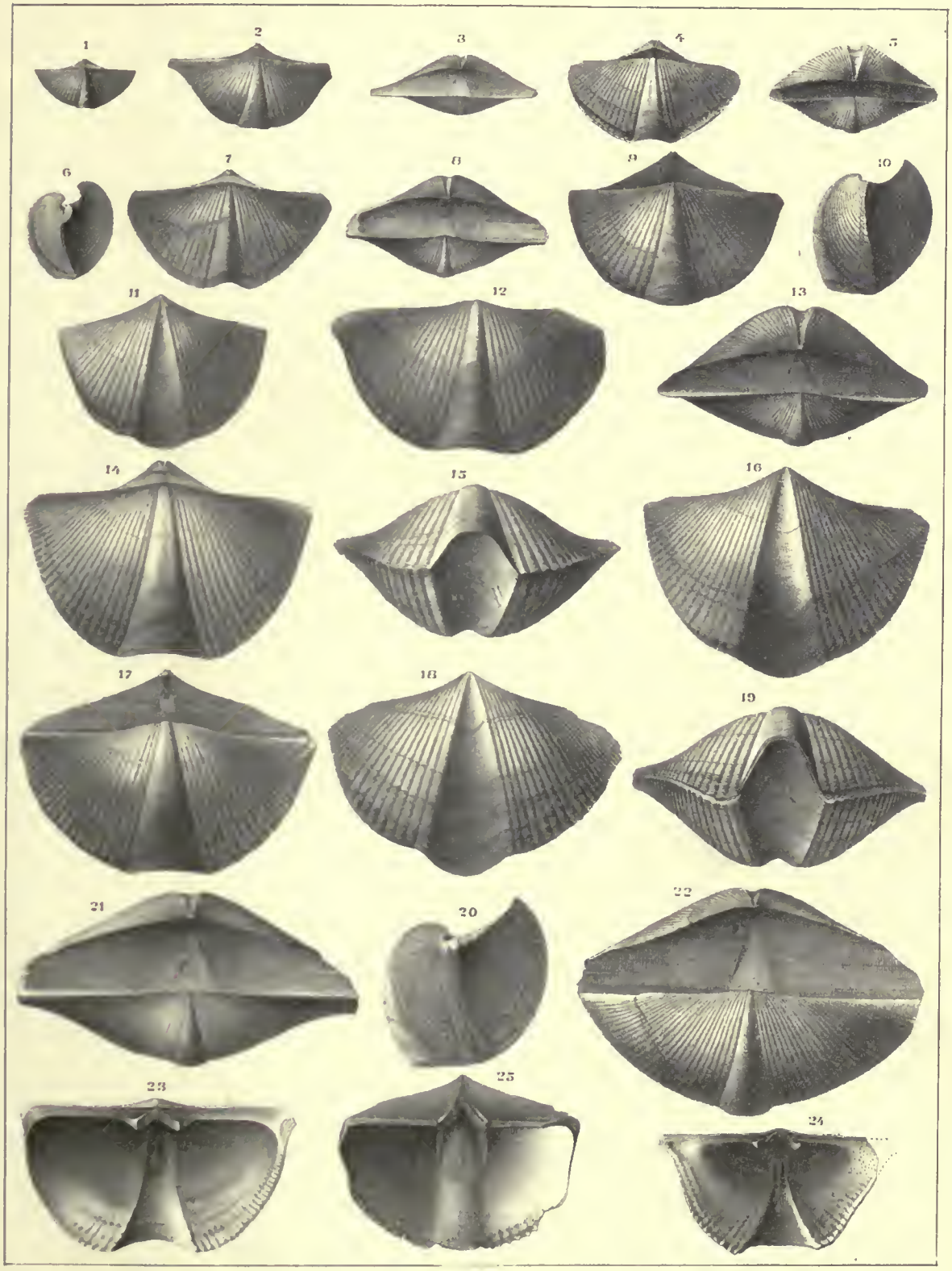

R. P. Whitfield del. Swinton, lith.

PLATE 38 A.

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Figs. 1 – 22. SPIRIFERA MACRONOTA..... 231

1 – 3. Dorsal, ventral and profile views of one of the smallest specimens which have been satisfactorily recognized as belonging to this species.

4 – 6. Ventral, cardinal and profile views of a specimen of medium size, with a high area and stronger plications than is usual in the species.

7 – 10. Dorsal, front, ventral and cardinal views of a somewhat characteristic specimen. The dorsal valve has been slightly crushed, giving a little less rotundity to the shell than natural.

11, 12. Ventral and cardinal views of a very characteristic ventral valve, showing the typically fine plications, shallow sinus, and vertical area.

13. Cardinal view of a large individual, having a very high area, and preserving the covering of the foramen in place. The specimen is somewhat crushed, giving an appearance of greater rotundity to the dorsal valve than natural.

14. View of a large dorsal valve possessing the characteristic form, with the fine plications.

15. Cardinal view of specimen fig. 14, showing the high vertical area and narrow deltidium.

16. Profile of specimen figs. 7 – 10, contrasting somewhat with fig. 6, in the height of area and proportional depth of the valves.

17, 18. Views of two characteristic dorsal valves, showing considerable variation in outline.

19. Cardinal view of a ventral valve, showing a much lower area than figs. 5, 10, 12 and 15. This, and figures 10 and 15, show the callus within the foramen extending to varying distances from the apex in the different individuals.

20. Interior of a dorsal valve, showing the dental sockets, cardinal process, and muscular impression.

21. Interior of the ventral valve, fig. 19, showing the muscular impression and dental plates.

22. Interior of a smaller ventral valve, showing muscular impression, dental lamellæ, etc.

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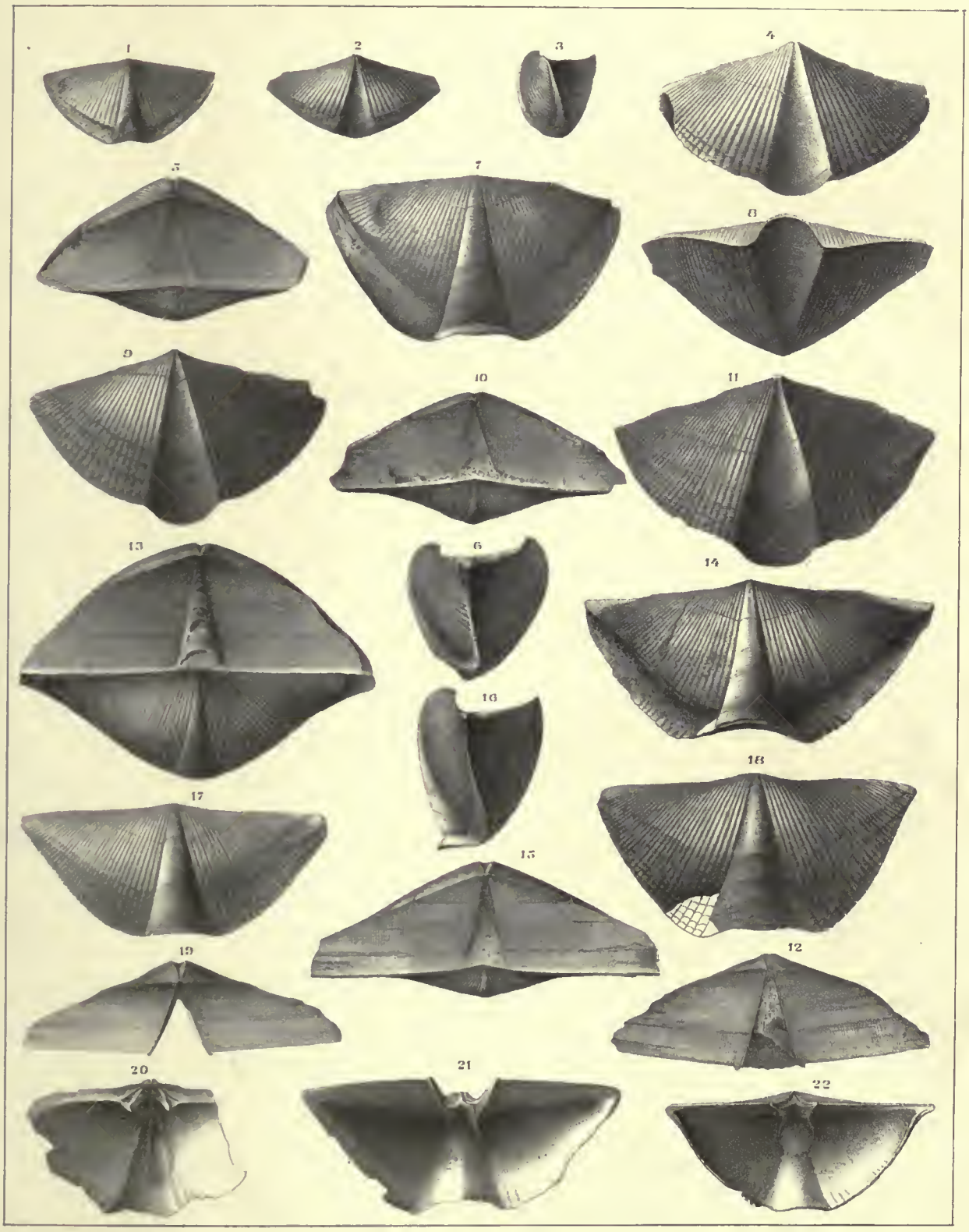

Swanton, lel. et lith.

PLATE 38*.

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Figs. 1–11. SPIRIFERA MEDIALIS..... 227

1. Dorsal valve of a small specimen, with extended cardinal extremities and fine plications.
2–4. Dorsal, ventral and cardinal views of an extended form, having a high, nearly vertical, cardinal area and narrow deltidial opening.
5, 6. Dorsal and cardinal views of a specimen of medium size, having fine plications, a high area, and extended cardinal extremities.
7. Dorsal valve of a specimen having a triangular form, from the great extension of the hinge line. This is a somewhat unusual form.
8–11. Dorsal, ventral, cardinal and profile views of a narrow ventricose form, having a semicircular outline, and a high, almost vertical area. The surface is strongly marked with concentric lines of growth.

Figs. 12–18. SPIRIFERA MEDIALIS var. EATONI..... 229

12–15. Dorsal, profile, cardinal and front views of a specimen of medium size and ventricose form, characteristic of this variety.
16–18. Dorsal, cardinal and front views of a larger and somewhat unsymmetrical specimen.

Figs. 19–22. SPIRIFERA MEDIALIS var..... 227

19. Cardinal view of a ventral valve with a high vertical area.
20. Cardinal view of a still narrower form which is somewhat distorted. The area is vertical and the foramen very narrow.
21, 22. Ventral and cardinal views of an exfoliated specimen, having very fine plications and high area, which is somewhat receding towards the apex; from limestone in the Hamilton shales, at Eighteen Mile Creek, shore of Lake Erie.

Figs. 23–32. SPIRIFERA ANGUSTA..... 230

23, 24. Dorsal and ventral views of a young individual of a short form.
25–27. Dorsal, ventral and cardinal views of a larger specimen, having the hinge line more extended.
28–31. Dorsal, ventral, cardinal and profile views of a large specimen with extended cardinal extremities and a high sloping area.
32. Ventral view of a cast of a specimen with a short hinge line and rounded front margin. The mucronate extensions of the hinge are so nearly solid that the filling of these portions of the shell is rarely preserved in casts, and owing to the loss of this part they appear to have a shorter hinge line.

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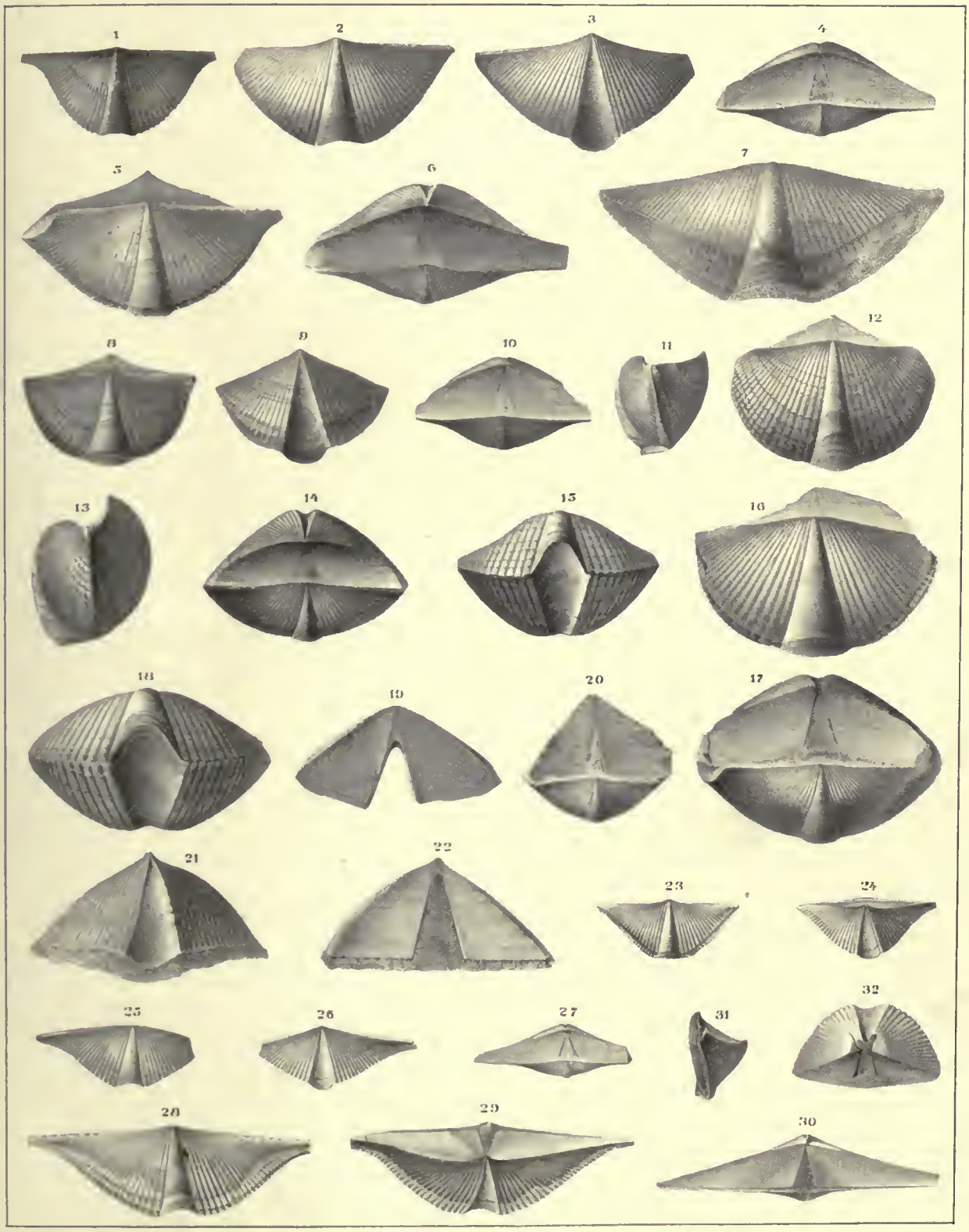

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Figs. 1–12. SPIRIFERA LÆVIS 239

1. View of a cast of a dorsal valve of a small individual.
2. Cast of a ventral valve of a small individual, showing the muscular impression.
3. Dorsal view of an imperfect specimen, showing the ventral area, and the deltidium in place.
4. Cast of a dorsal valve of a large individual.
5. Cardinal view of a ventral valve, showing the deltidium in place.
6. Interior of a ventral valve, showing the area, muscular impression, with the deltidial plate covering the upper part of the foramen.
7. Exterior of a large ventral valve preserving the shell and showing a remarkably wide subangular sinus, with obscure plications on the sides of the shell.

8–11. Casts of ventral valves, showing considerable variation in the size and proportions of the muscular impression.

12. Cardinal view of a cast of a ventral valve.

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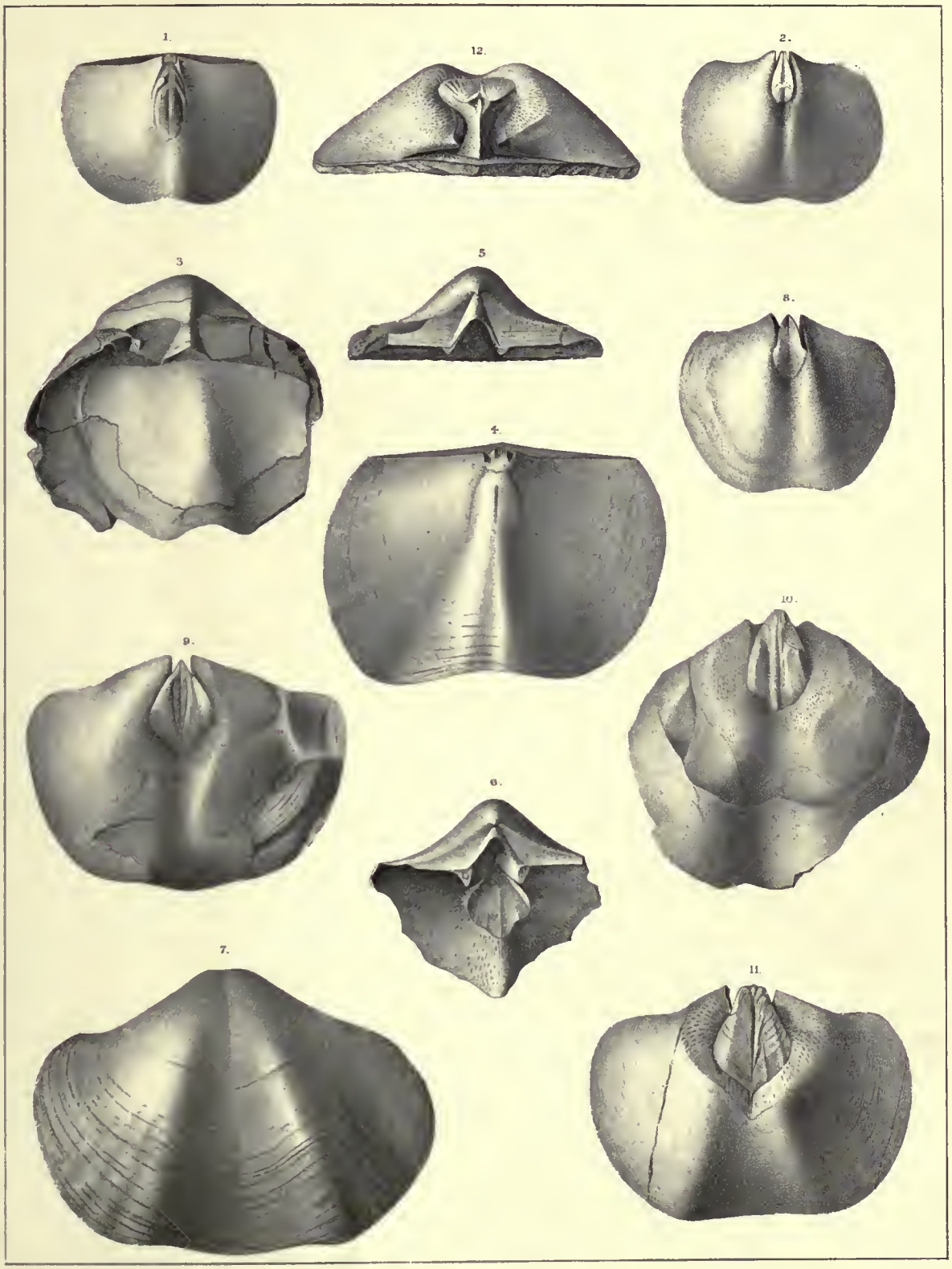

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Figs. 1 – 13. SPIRIFERA MESACOSTALIS..... 240

1, 2. Dorsal and ventral valves of small individuals, from Ithaca, N. Y., which do not possess the plication in the sinus.

3. Dorsal valve having the cardinal extremities very much extended. This is the form originally described in the Fourth District Rept., as *Spirifera acuminata*.

4. Dorsal valve, showing the character of the species.

5. Ventral valve, having the general characters of *Spirifera mucronata*, but possessing the plication in the mesial sinus.

6. View of the dorsal valve having the mesial fold composed of three equal plications.

7 – 9. Ventral valves presenting the ordinary characters of the species, but showing considerable variations in the cardinal extremities.

10. 11. Casts of ventral valves of this species.

12, 13. Cardinal view of ventral valves, showing considerable variation in the height of area.

Figs. 14 – 22. SPIRIFERA MESASTRIALIS..... 242

14, 15. Dorsal valves of small individuals.

16, 17. Dorsal valves of larger individuals, having the cardinal extremities rounded or but little extended.

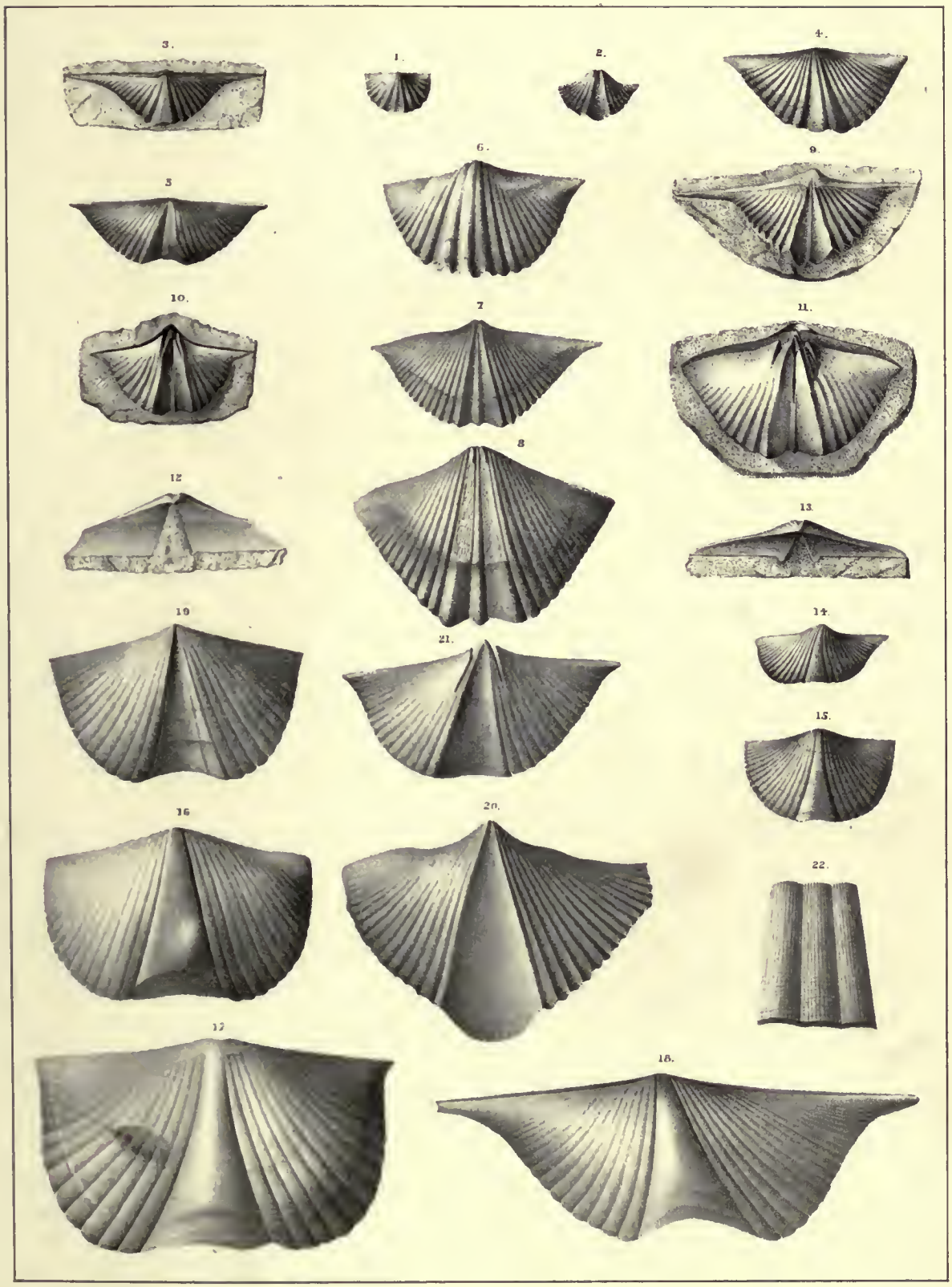
18. Dorsal valve of a specimen of this species, having the cardinal extremities greatly extended.

19 – 21. Ventral valves, showing some variation in the extent of the cardinal extremities.

22. Enlargement of surface, showing the striated plications, and in one part the fine concentric striæ which cancellate them. The latter feature is only seen on the most perfectly preserved specimens.

(Figs. 16, 18, 19, 21, were intended to show fine striations on the sinus, but these unfortunately are only shown upon the early impressions.

(BRACHIOPODA.)



R P Whitfield, del.

Swinton. lith.

PLATE 41.

Page

Figs. 1 – 19. SPIRIFERA DISJUNCTA..... 243

(The references to this plate on page 216, should be to plate 42.)

1 – 3. Views of small individuals with short or rounded extremities.

4. An individual with the cardinal extremities much extended.

5 – 9. Specimens showing some variations in the extent of the cardinal line, but all possessing a simple mesial fold.

10 – 16. Specimens showing variations in the form of the valves having a double mesial fold.

17. Cast of an individual preserving both valves, with cardinal extremities extended, the mesial fold being narrow and angular.

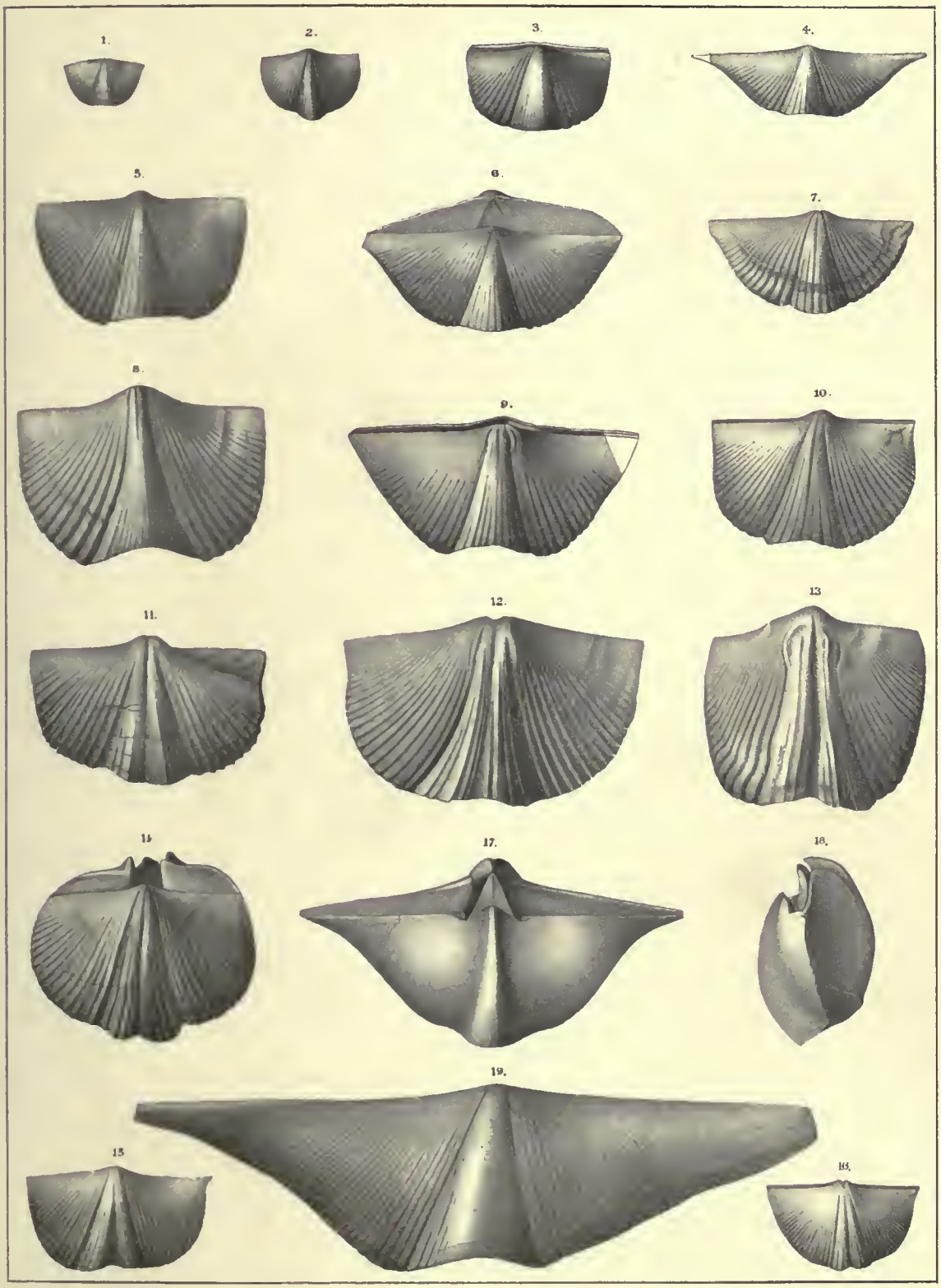
18. Profile view of specimen, fig. 17, showing the gibbosity of the valves.

19. An individual with extended cardinal extremities, and a broad rounded mesial fold.

(The figures on this plate are all dorsal views.)

CHEMUNG GROUP.

(BRACHIOPODA.)



R P Whitfield, del

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PLATE 42.

Page

Figs. 1 – 20. SPIRIFERA DISJUNCTA 243

(The references to this plate, on page 246, should be to plate 41.)

1. A small narrow form retaining the shell.
2. A cast of a young individual.
3. Cast of a valve of usual form.
4. 5. Valves of small forms, having the cardinal extremities short and rounded; the latter figure showing the extension of the dental lamellæ nearly to the front of the valve.
6. Cardinal view of a specimen having a very high area and wide foramen.
7. 8. Forms in which the cardinal area and foramen are proportionally narrow.
9. 11. Individuals of the prevailing form retaining the shell.
10. Cast of a broader form.
12, 14, 15. Specimens showing extreme variation of muscular impression.
13, 19, 20. Individuals showing great extension of the cardinal extremities. *Spirifera* (*Delthyris*) *perlata*, Conrad. *D. caspidata*, Hall.
16. Cardinal view of the specimen, fig. 15, showing short thickened dental lamellæ.
17. Cast of a small individual, showing dental lamellæ extending to the front of the valve.
18. Interior of a specimen preserving a portion of the shell and showing the form of the muscular impression.

(The figures on this plate are all ventral valves.)

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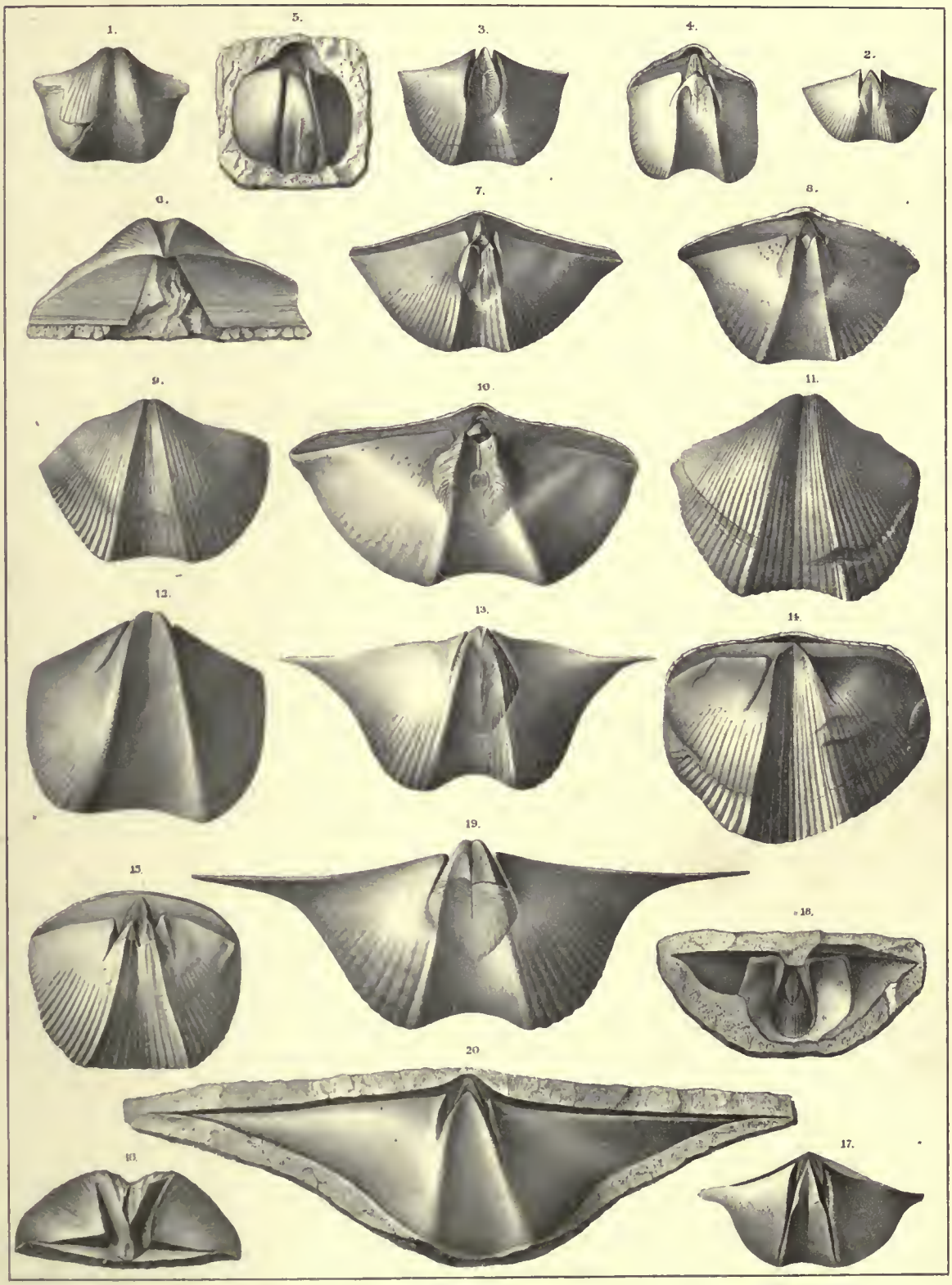

R. P. Whitfield, del. Swinton, lith.

PLATE 43.

Page

Figs. 1 – 8. SPIRIFERA ALTA..... 248

1–3. Casts of dorsal valves, showing the extent of area, dental cavities, and muscular impression.

4, 5. Two views of a cast of a ventral valve, showing the muscular impression and sinuate outline of the valve in front.

6, 8. Cardinal views of a ventral valve taken from gutta-percha casts, from natural moulds, showing a partial closing of the triangular foramen by shelly matter, which is not the true deltidial plate.

7. Cardinal view of a cast of a ventral valve, showing the cavities left by the removal of the dental lamellæ, and the concave impression of the inner surface of the shelly plate, which partially closed the foramen.

(BRACHIOPODA.)

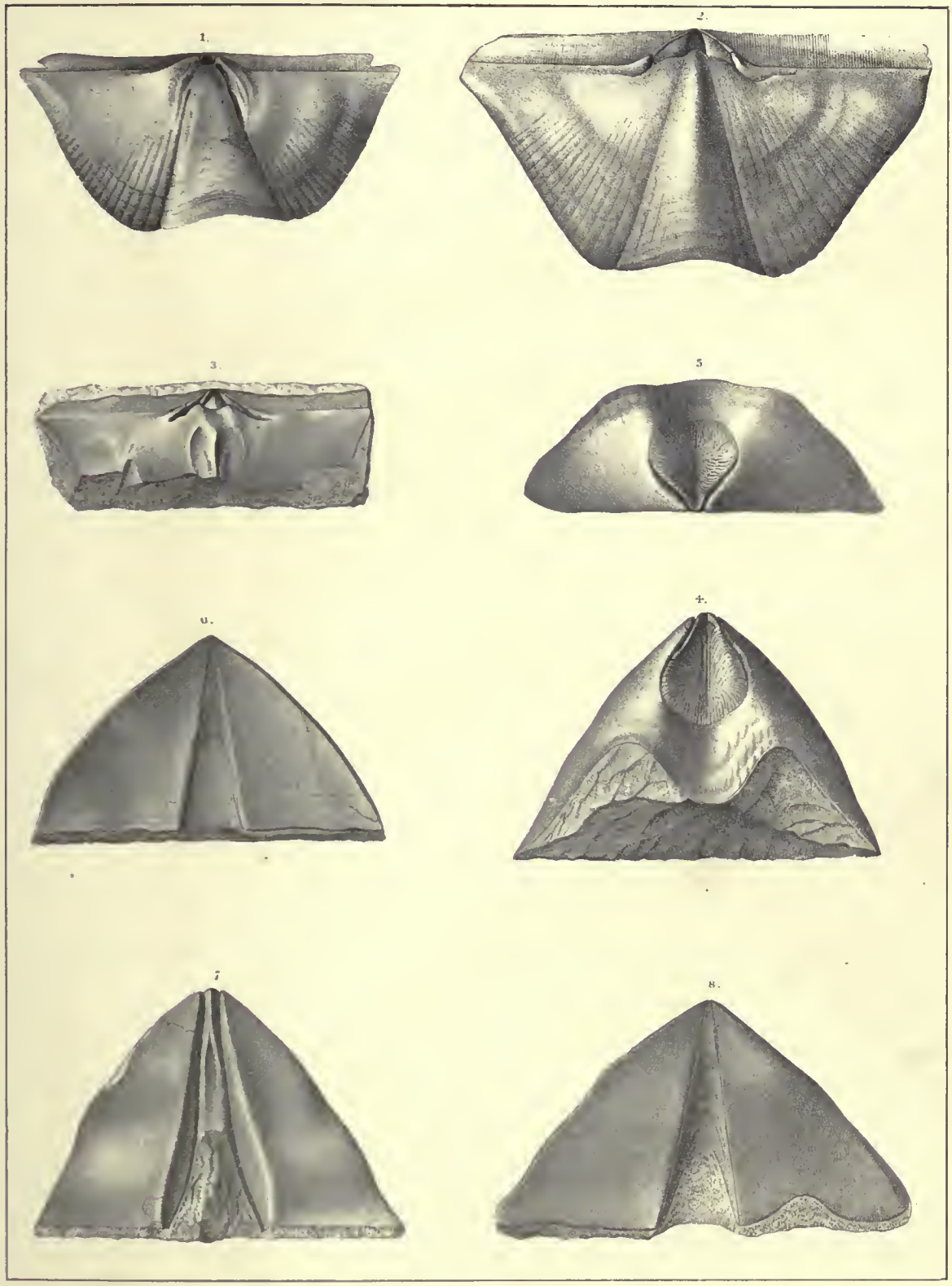

PLATE 44.

Page

Figs. 1 – 6. AMBOCŒLIA PRÆUMBONA 262

1, 2. Dorsal valves of specimens of the ordinary size and form.
3, 4. Ventral and profile views of the ordinary form.
5. Ventral view of a narrow elongated individual, which is not an uncommon form in some localities.
6. View of a cast of a ventral valve, showing muscular impression and pustulose markings of the central portions of the shell; enlarged to two diameters.

Figs. 7 – 18. AMBOCŒLIA UMBONATA 259

7 – 10. Dorsal, ventral, profile and cardinal views of a large and well preserved individual, possessing all the ordinary features of the species.
11, 12. Interiors of dorsal valves.
13. Interior of a well preserved ventral valve.
14, 15. Enlarged to three diameters from figs. 11 and 12, to show the variations in the cardinal processes, dental sockets and muscular impressions.
16. An enlargement to three diameters, of specimen fig. 13, showing the cardinal area, triangular foramen and teeth.
17. Ventral view of a specimen, showing the internal spires; enlarged to two diameters.
18. View of a specimen, from the Marcellus shales. This is the form originally described as *Ambocœlia* (*Orthis*) *nucleus*; enlarged to two diameters.

Figs. 19 – 25. AMBOCŒLIA UMBONATA var. GREGARIA 261

19. Dorsal valve; enlarged to two diameters.
20, 21. Ventral and profile views of a specimen preserving the shell.
22. Cast of a dorsal valve.
23. Cast of a dorsal valve of another individual, enlarged to two diameters to show muscular impressions and cavities left by the removal of the cardinal process.
24. Cast of a ventral valve.
25. Cardinal view of the cast of a ventral valve.

Figs. 26–33, 38–52. CYRTINA HAMILTONENSIS 268

26 – 30. Dorsal, ventral, cardinal, profile and front views of a large individual as it occurs in the State of New York.
31, 32. Dorsal views of two individuals, which show a variation in the number of plications.
33. Dorsal view of a specimen which has the beak of the ventral valve strongly curved laterally.
38 – 40. Dorsal, ventral and profile views of a large specimen, from Canada West, showing a strongly curved beak, the foramen covered by the pseudo-deltidial plate which is perforated in the upper part.
41, 42. Dorsal and ventral views of a still larger specimen, from the same locality with the last. This specimen also shows the perforated pseudo-deltidial plate.
43. Interior of a dorsal valve; enlarged to two diameters.
44. A still further enlargement of the hinge portions of specimen, fig. 43, to show the cardinal process, dental sockets, etc.
45 – 47. Dorsal, ventral and cardinal views of an internal cast, showing the muscular impression and cavity left by removal of the mesial septum and dental lamellæ; figures enlarged to two diameters.
48. Longitudinal section, showing the dental lamellæ of one side and the form and extent of the mesial septum of the ventral valve.
49. A transverse section through the middle of the ventral valve, showing a section of the spiral cones, and of the dental lamellæ and their junction with the mesial septum.
50. Enlargement of an individual, from the Corniferous limestone at the Falls of the Ohio, showing the mesial septum extending from the beak to the centre of the valve, and also the spiral cones with their apices directed into the rostral cavity of the ventral valve.
51. Dorsal view of a specimen of this species, from Independence, Iowa.
52. Enlargement, showing the pustulose character of the surface.

Figs. 34 – 37. CYRTINA HAMILTONENSIS var. RECTA 270

34 – 36. Dorsal, ventral and cardinal views of a specimen of this variety, from the Hamilton group.
37. A ventral view of a specimen of this form, from the Chemung group.

Figs. 53 – 55. CYRTINA CURVILINEATA? 270

53 – 55. Dorsal, ventral and profile views of the specimens described.

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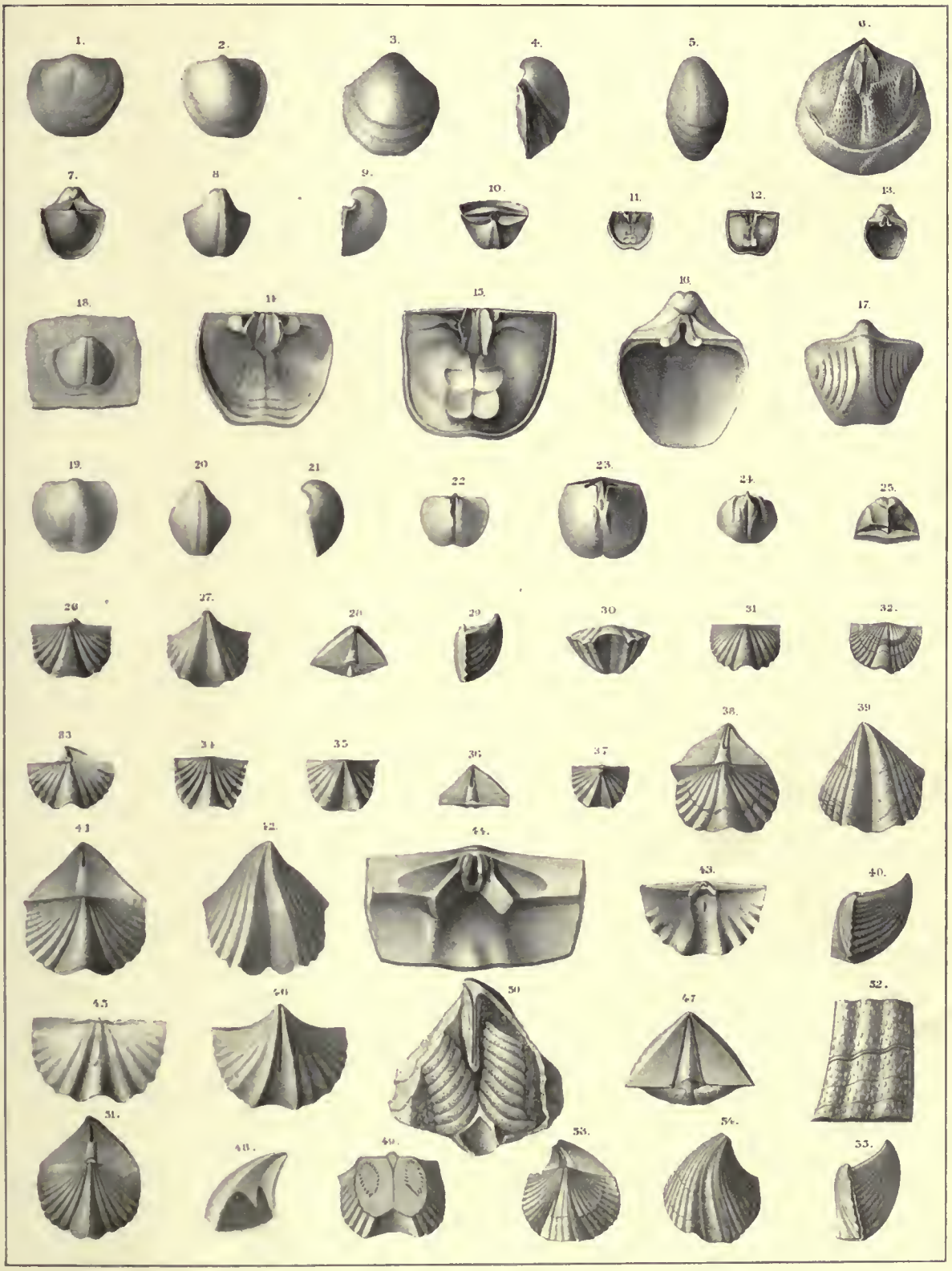

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PLATE 45.

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Figs. 1–6. RHYNCHOSPIRA LEPIDA..... 276

1. A ventral view, natural size.
2–4. Dorsal, ventral and profile views of a specimen of the prevailing form; enlarged to two diameters.
5. Dorsal view of an individual of an elongate form, in which the sinus of the dorsal valve is more strongly marked than usual (enlarged).
6. A still further enlargement of the rostral portion of fig. 2, for the purpose of showing deltidial plates, foramen, etc. (The lithographer has unfortunately omitted the lines marking the limits of the deltidial plates.)

Figs. 7–15. TREMATOSPIRA GIBBOSA..... 272

7, 8. Dorsal and ventral views of a small specimen.
9. Dorsal view of a specimen of medium size.
10–14. Dorsal, ventral, cardinal, profile and front views of a full grown individual.
15. Enlargement of the cardinal portion of a dorsal valve of this species, showing the peculiar cardinal process and slender mesial septum.

Figs. 16–32. TREMATOSPIRA HIRSUTA 274

16. A dorsal view of an individual, from the Corniferous limestone of Louisville, Ky.
17–19. Dorsal views of specimens, showing variations in size and development of the mesial fold and sinus; fig. 19 being essentially destitute of these features.
20. Ventral views of a large individual.
21, 22. Dorsal and profile views of a round and gibbous specimen.
23–27. Dorsal, ventral, profile, cardinal and front views of a full grown individual.
28. Interior of a dorsal valve.
29. An enlargement of the upper part of fig. 28, showing cardinal process, dental sockets, and bases of the crura.
30. Interior of a ventral valve.
31. Enlargement of the beak of fig. 30, showing the teeth, false area and foramen.
32. An individual having the greater part of the dorsal valve removed, showing the internal spires and bases of the crura.

Figs. 33–57. NUCLEOSPIRA CONCINNA..... 279

33. Cast of a ventral valve, from the Schoharie grit.
34, 35. Dorsal and profile views of a specimen, from the Upper Helderberg limestone.
36, 37. Dorsal views of small individuals, from the Hamilton group; the latter preserving the fine hair-like setæ on a part of the shell.
38, 39. Dorsal and profile views of a specimen where the valves are of nearly equal depth.
40, 41. Dorsal views of flattened specimens which preserve the fine setæ very beautifully.
42–46. Dorsal, ventral, profile, cardinal and front views of a large and well preserved specimen where the valves are of unequal depth.
47, 48. Interior and profile views of a dorsal valve, showing the size and form of the cardinal process.
49. Enlargement of the cardinal process, showing the small elevated pad for the attachment of the cardinal muscles, the dental sockets, and the points for the attachment of the crura.
50. Interior of a ventral valve.
51. Enlargement of the beak of the ventral valve, showing the teeth and false area.
52. View of a specimen showing the spires.
53, 57. The internal cast of a dorsal and a ventral valve; enlarged to two diameters.
54. The cast of a ventral valve of the natural size.
55, 56. The casts of dorsal valves, of the natural size, showing some variation in the form and markings.
58. Enlargement of the surface, showing the fine setæ, and the bases of others which have been broken away, giving a minutely pustulose surface. It is this feature which gives the apparent punctate texture to the surface of these shells.

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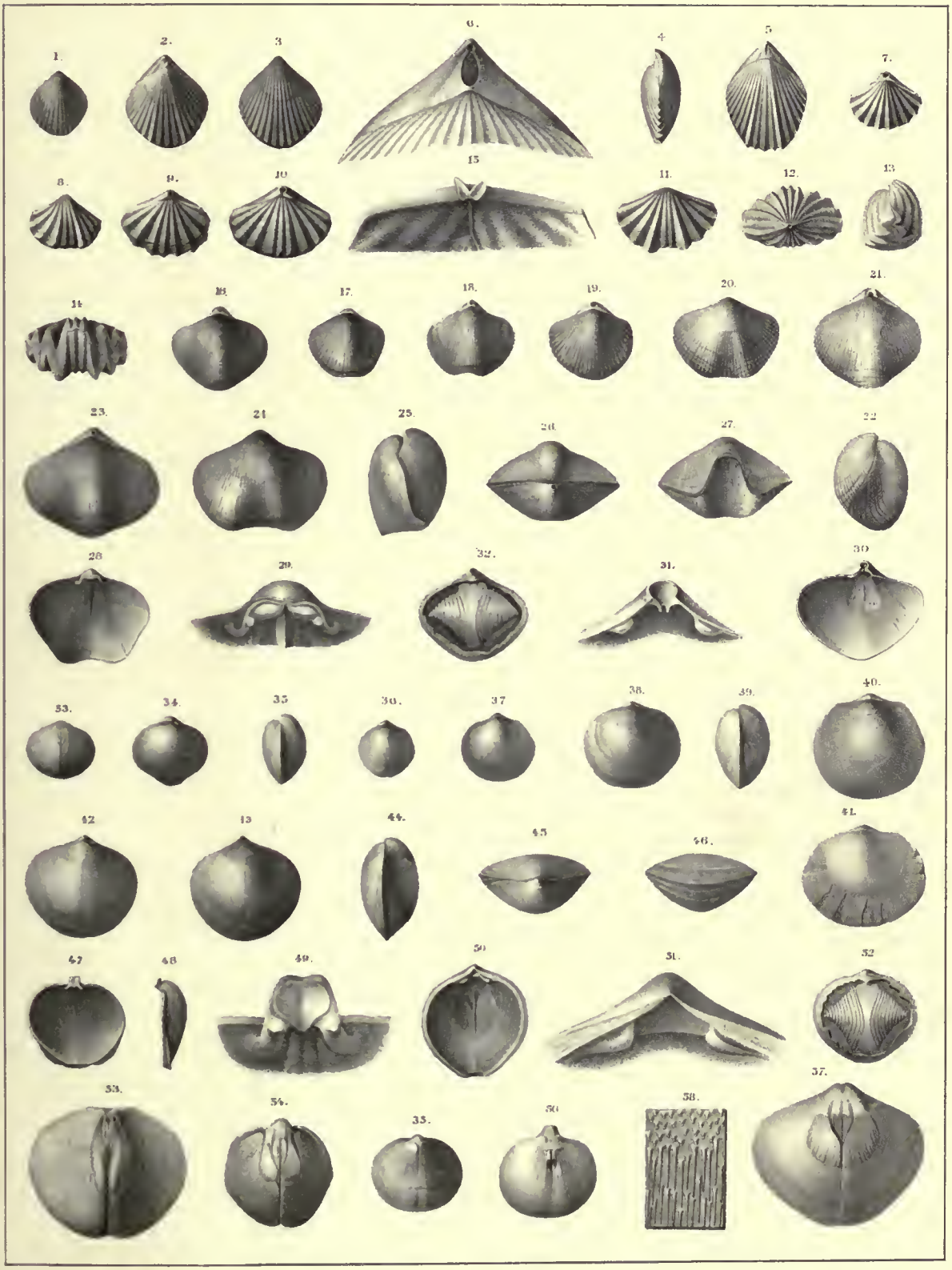

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PLATE 46.

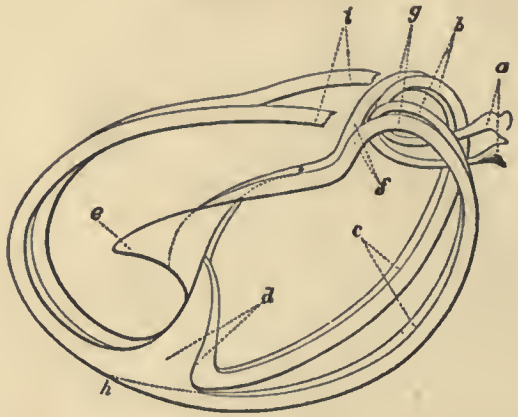
Page

Figs. 1–4. ATHYRIS VITTATA..... 289

1–4. Dorsal, ventral, profile and front views of a specimen from the Falls of the Ohio, presenting the ordinary characters of the species.

In the description of the internal spires of this species, page 290, the letter *h* is used to indicate the junction of the intercalated lamellæ, but was accidently omitted from the figure on page 289. The corrected figure is therefore inserted in this place.

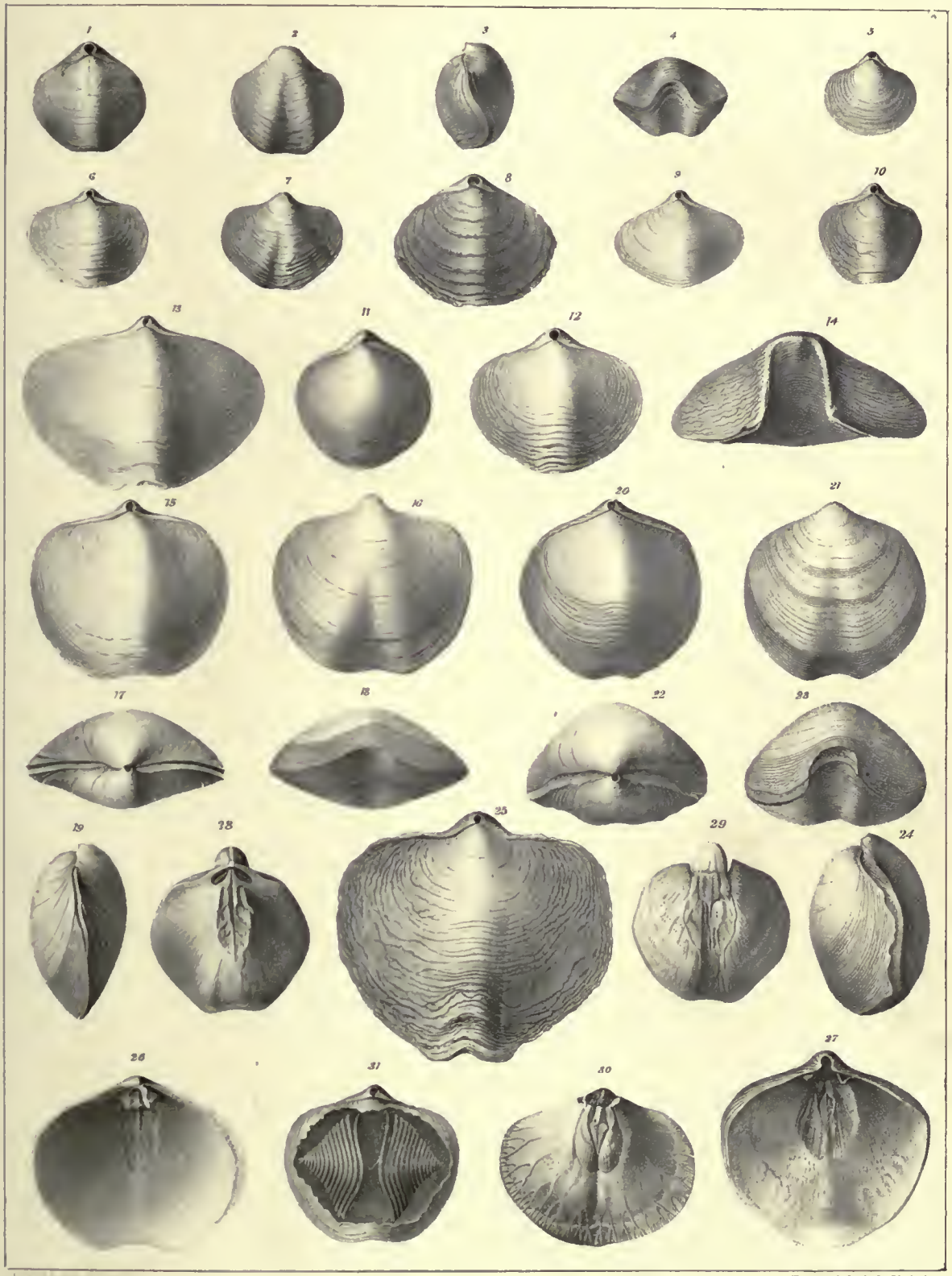
ATHYRIS VITTATE.



Figs. 5–31. ATHYRIS SPIRIFEROIDES.. 285

5. A small individual without mesial fold or sinus.
6, 7. Views of small specimens, of ordinary form, in which the fold and sinus are partially developed.
8 A larger specimen, showing a strongly lamellose surface.
9. Dorsal view of a laterally expanded specimen.
10, 11. Dorsal views of rounded gibbous forms.
12. Dorsal view of a specimen of the ordinary form and of medium size.
13. Dorsal view of an extremely broad individual.
14. Front view of specimen, fig. 13, showing extreme elevation in front.
15–19. Dorsal, ventral, cardinal, front and profile views of a well defined and moderately gibbous form.
20–24. Dorsal, ventral, cardinal, front and profile views, of a rounded, gibbous and thickened shell.
25. Dorsal view of a large specimen, showing a strongly lamellose surface.
26, 27. Interiors of a dorsal and a ventral valve, showing hinge structure and muscular impressions.
28, 29. Dorsal and ventral views of an internal cast of this species, from the Hamilton group, Hardy county, Va., showing very distinctly the impressions of the muscular markings.
30. Ventral view of a cast from the same formation in New York, showing the muscular and vascular markings in a still more perfect state.
31. A specimen, which has been cut to show the spires. The intercalated lamellæ are not seen in this view. (See page 284 and plate 47, fig. 8.)

UPPER HELDERBERG AND HAMILTON GROUPS.



Bowen & Co lith Phila.

PLATE 47.

Page

Figs. 1–7. ATHYRIS CORA..... 291

1, 2. Dorsal and ventral views of a small and well preserved specimen.

3–7. Dorsal, ventral, profile, cardinal and front views of a full grown and perfectly formed specimen; the shell is somewhat exfoliated, and does not show the exterior surface characters.

Fig. 8. ATHYRIS SPIRIFEROIDES..... 285

8. The ventral side of the specimen fig. 31, pl. 46, showing the intercolated lamellæ of the spires near the upper part between the cones.

Figs. 9–20. ATHYRIS ANGELICA..... 292

9–13. These figures are from specimens which preserve the external shell and surface characters, and illustrate the great variety of form presented by this species. Fig. 9, is of a dorsal valve; the others are of ventral valves.

14. A cast of the ventral valve of a young individual.

15. The ventral side of a large and rather elongated specimen, showing the muscular markings and filling of the rostral cavity.

16–19. Dorsal, ventral, profile and front views of the internal cast of a short ventricose individual.

20. Enlargement of the surface to show the lamellose concentric striæ and the finer radiating lines.

Figs. 21–33. ATHYRIS POLITA..... 293

21, 22. Dorsal and ventral views of a small individual.

23–26. Dorsal, ventral, profile and front views of a specimen of the ordinary size and proportions. The shell has been almost entirely exfoliated from the specimen.

27–29. Dorsal, ventral and cardinal views of a more gibbous and more perfect cast of the species, showing the muscular impressions and filling of the rostral cavity.

30. The exterior of a nearly perfect specimen, showing the surface striæ.

31. Dorsal view of a cast of the species, showing the muscular impressions.

32, 33. Ventral views of casts, showing the muscular impressions and filling of the dorsal cavity. The species not verified.

Figs. 34–38. MERISTELLA SCITULA..... 302

34, 35. Dorsal and ventral views of a specimen of medium size.

36–38. Dorsal, ventral and profile views of a larger individual.

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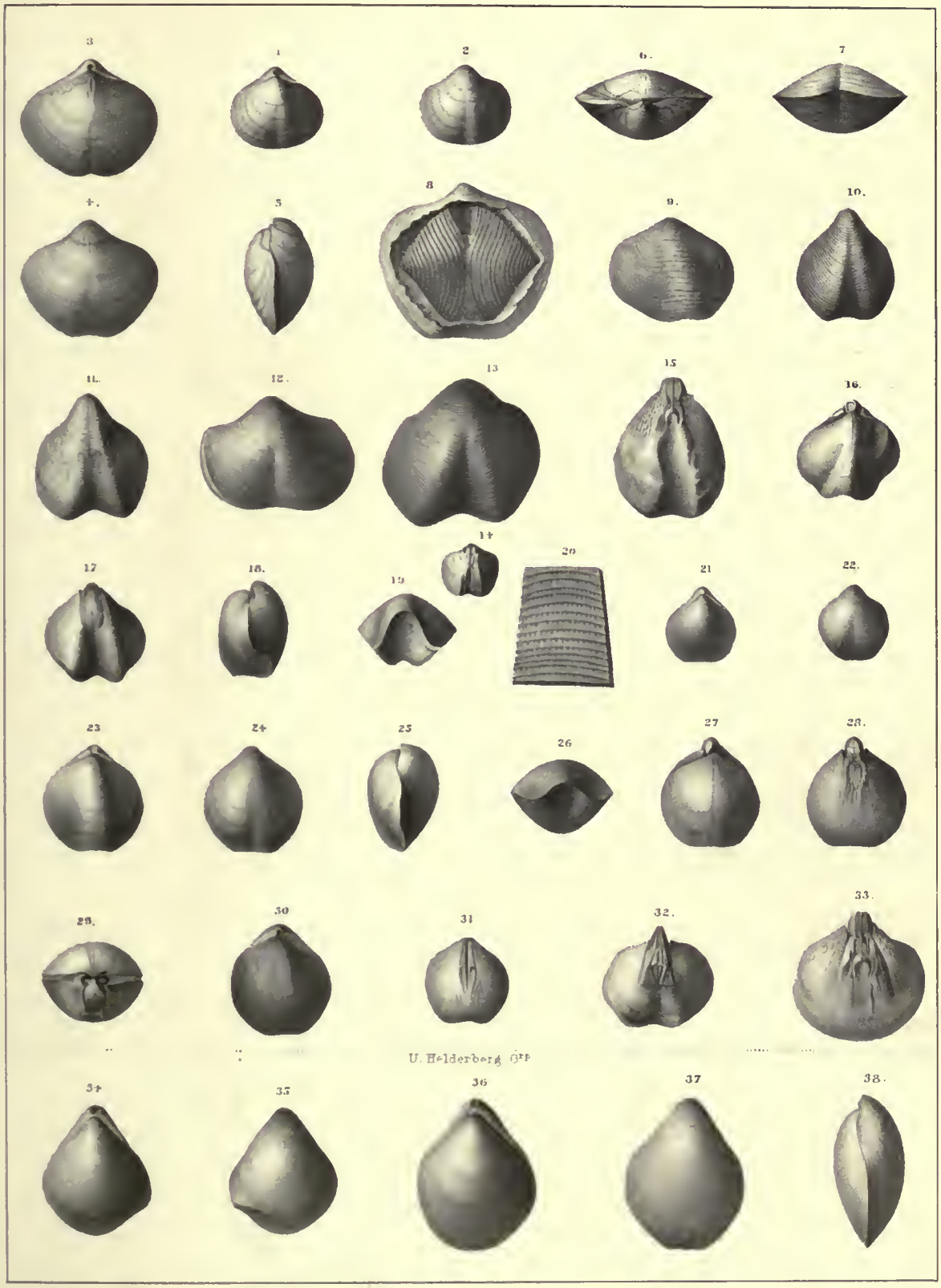

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PLATE 48.

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Figs. 1–25. MERISTELLA NASUTA 299

1. The cast of a large dorsal valve.
2. The cast of an imperfect specimen of the dorsal valve, showing more distinctly the muscular impressions.
3, 4. Cast of ventral valves of an elongated form, with deep muscular impressions.
5, 6. Casts of ventral valves of larger individuals, showing somewhat different forms of muscular impressions. The above are from the Schoharie grit.
7–9. Dorsal, ventral and profile views of a young individual of a lenticular form, which is not produced in front.
10. A small elliptical form which is produced in front.
11, 12. Dorsal and profile views of a larger and proportionally shorter form than fig. 10.
13. A front view of a specimen, showing an extreme elevation of the ventral valve.
14. Dorsal view of a broad form of the species.
15, 16. Dorsal and ventral views of a large individual of a broadly oval and somewhat quadrilateral form.
17. The interior of a dorsal valve, showing the hinge plate and muscular impression.
18. The interior of an imperfect ventral valve.
19. Dorsal view of a specimen, showing the internal spires and median septum.
20, 21. Dorsal and profile views of a cast in chert, from the Corniferous limestone.
22. The cardinal view of another cast, showing the muscular impressions, the filling of the rostral and teeth cavities, and the spaces left by the removal of the dental lamellæ, hinge plate and median septum. Figs. 7–22 are of specimens from the Upper Helderberg limestones.
23–25 Dorsal, profile and ventral views of a large individual, which is much produced in front and having a comparatively shallow dorsal valve; from the Schoharie grit. This is the form originally described as *Meristella elissa*.

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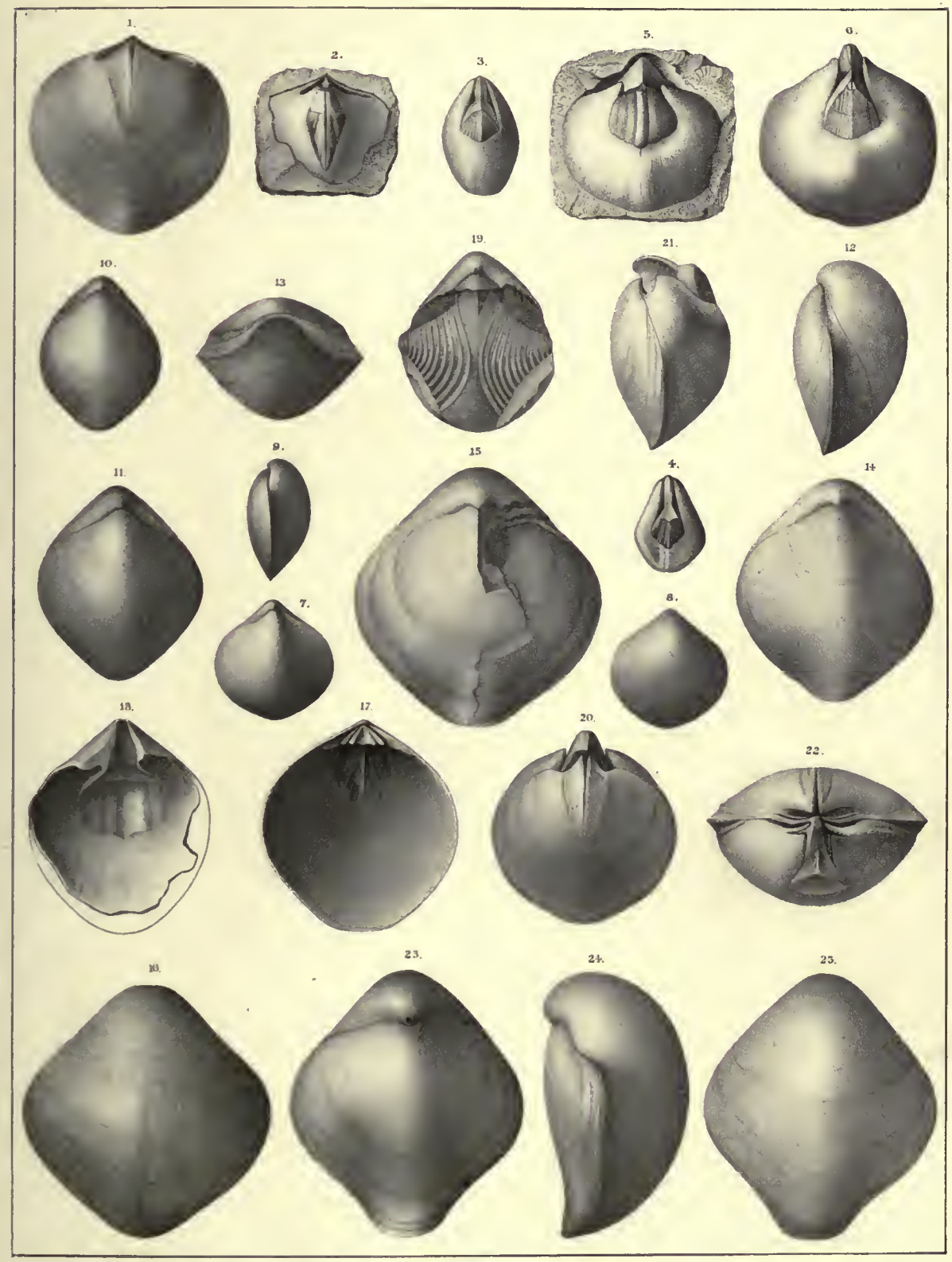

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PLATE 49.

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Figs. 1–4. MERISTELLA META 308

1–4. Dorsal, ventral, profile and front views of a specimen of the ordinary size.

Figs. 5–22. MERISTELLA BARRISI 304

5 Dorsal view of a small individual.

6, 7. Dorsal and profile views of a very gibbous form.

8, 9, 11. 12. Dorsal views of specimens illustrating the prevailing size and forms of the species.

10. A ventral view of the specimen, fig. 9.

13–15. Dorsal, profile and front views of an unusually elongated and gibbous form.

16–19. Dorsal, ventral, profile and front views of large forms, the front view offering a strong contrast with fig. 15.

20. A ventral view of a broad form of the species.

21, 22. Dorsal and ventral views of casts of this species.

Figs. 23–35.* MERISTELLA HASKINSI 306

23–25. Dorsal, profile and front views of a small lenticular form which shows little gibbosity.

27, 26, 30. Profile, dorsal and front views of a more gibbous form.

28, 31. Dorsal and ventral views of a larger form, showing a greater extension of beak.

29, 32, 33. Profile, dorsal, and ventral views of a specimen of the ordinary size and form.

34. Dorsal view of a large individual, showing the foramen and deltidial plates.

35. Cast of a ventral valve.

36. A dorsal view of a partial cast. The specimen is referred with doubt to this species.

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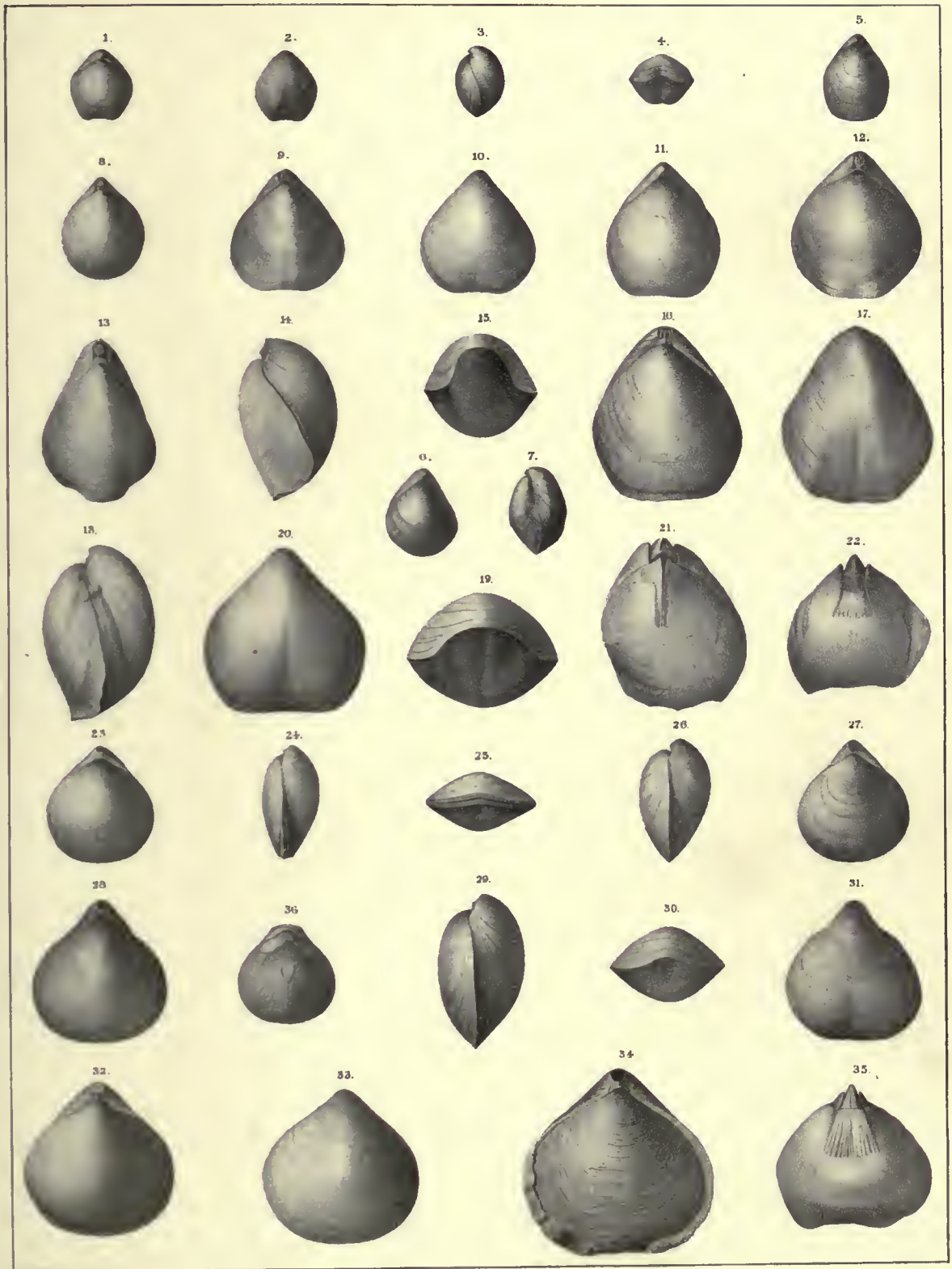

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PLATE 50.

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Figs. 1 – 12. MERISTELLA DORIS..... 303

1. A dorsal view of a small specimen, from the Schoharie grit.
2. A dorsal view of a small individual. This, and the following figures, are of specimens from the Corniferous limestone.
3, 4. Dorsal and ventral views of an unsymmetrical specimen, of medium size.
5, 6. Dorsal and profile views of a specimen of medium size and perfect form.
7. Ventral view of a large individual, which is somewhat imperfect at the beak.
8 – 10. Dorsal, profile and front views of a large individual.
11. The dorsal valve of a large individual.
12. Cardinal view of a cast, showing the muscular impressions and the cavities made by the removal of the dental lamellæ and median septum.

Figs. 13 – 17. MERISTELLA ROSTRATA..... 307

13 – 16. Dorsal, ventral, profile and front views of a specimen.
17. Dorsal view of a specimen, having a somewhat different form from the above.

Figs. 18 – 35. MERISTELLA (PENTAGONIA) UNISULCATA..... 309

18 – 20. Dorsal, ventral and cardinal views of a small specimen, presenting the ordinary characters of the species.
21. Dorsal view of a small individual, having a less extended hinge line, giving the shell a more triangular form.
22, 23. Dorsal and ventral views of a specimen of medium size.
24. A cardinal view of a somewhat larger individual, showing a deep sinus in the mesial fold.
25 – 29. Dorsal, ventral, front, cardinal and profile views of a large but not very gibbous specimen.
30 – 32 Ventral, front and cardinal views of a narrow gibbous form, from the Falls of the Ohio.
33, 34. Interiors of the dorsal and ventral valves, showing the hinge structure and muscular impressions. From the Falls of the Ohio, communicated by Major S. S. Lyon.
35. A cardinal view of a specimen, from the Hamilton shales of New York, showing a second fold on the cardinal margin of the dorsal valve.

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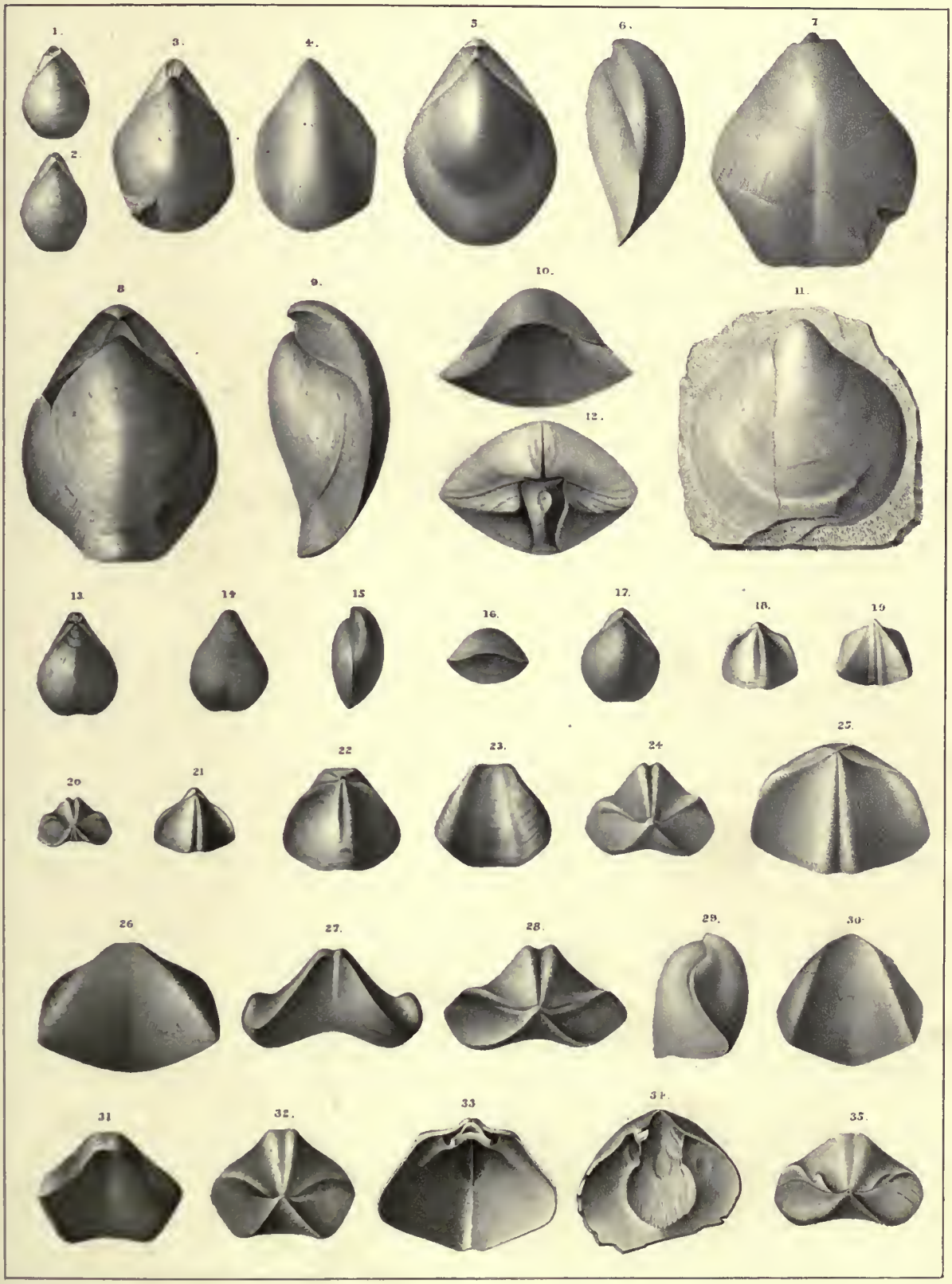

PLATE 51.

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Figs. 1–9. ATRYPA IMPRESSA..... 315

1–3. Dorsal, ventral and front views of a specimen of the ordinary form.

4, 5. Profile and front views of a very gibbous form, having the mesial portion of the dorsal valve more than usually impressed.

6. A cast of a dorsal valve, showing the muscular impressions and the imprint of the crenulated socket plates.

7. An enlargement from the upper portion of a specimen similar to that of figure 6, showing more distinctly the crenulations left by the removal of the socket plates.

8. A cast of an extremely gibbous dorsal valve, with a very prominent muscular scar, showing vascular lines and papillose ovarian markings.

9. Cast of a ventral valve, showing muscular impression and dental cavities.

Figs. 10–24. ATRYPA RETICULARIS..... 316

10. A dorsal valve of a broad form, with coarse plications, showing the marginal extension of the lamellæ; from New York.

11. A ventral valve without sinus, of the ordinary form of this species, as it occurs in the Corniferous limestone.

12–13. Profile and front views of a specimen from Cayuga, C. W., having a sinus in the ventral valve; of the ordinary size and form, as it occurs in the Corniferous limestone of New York and Canada.

14–16. Dorsal, profile and ventral views of a large individual of this form, from New York, the ventral side having the shell removed, showing the muscular markings and the papillose surface of the interior. The specimen fig. 10, this and the following ones, present some characters which might be regarded as of specific importance. The external features, general form, striæ, elevation of beak, etc., are distinctive, and may be found useful in characterizing a form intermediate between those with fine striæ, like representations in figs. 11–13, and the *A. aspera* or *A. spinosa*.

17. Dorsal view of a small specimen, from the hydraulic beds at the Falls of the Ohio.

18–22. Dorsal, ventral, profile, cardinal and front views of a specimen illustrating the prevailing form in the hydraulic beds at the Falls of the Ohio.

23. Interior of a ventral valve, showing the muscular impressions and papillose surface.

24. The hinge portion of the dorsal valve of the preceding specimen, showing the bases of crura and crenulate sockets; from the Falls of the Ohio.

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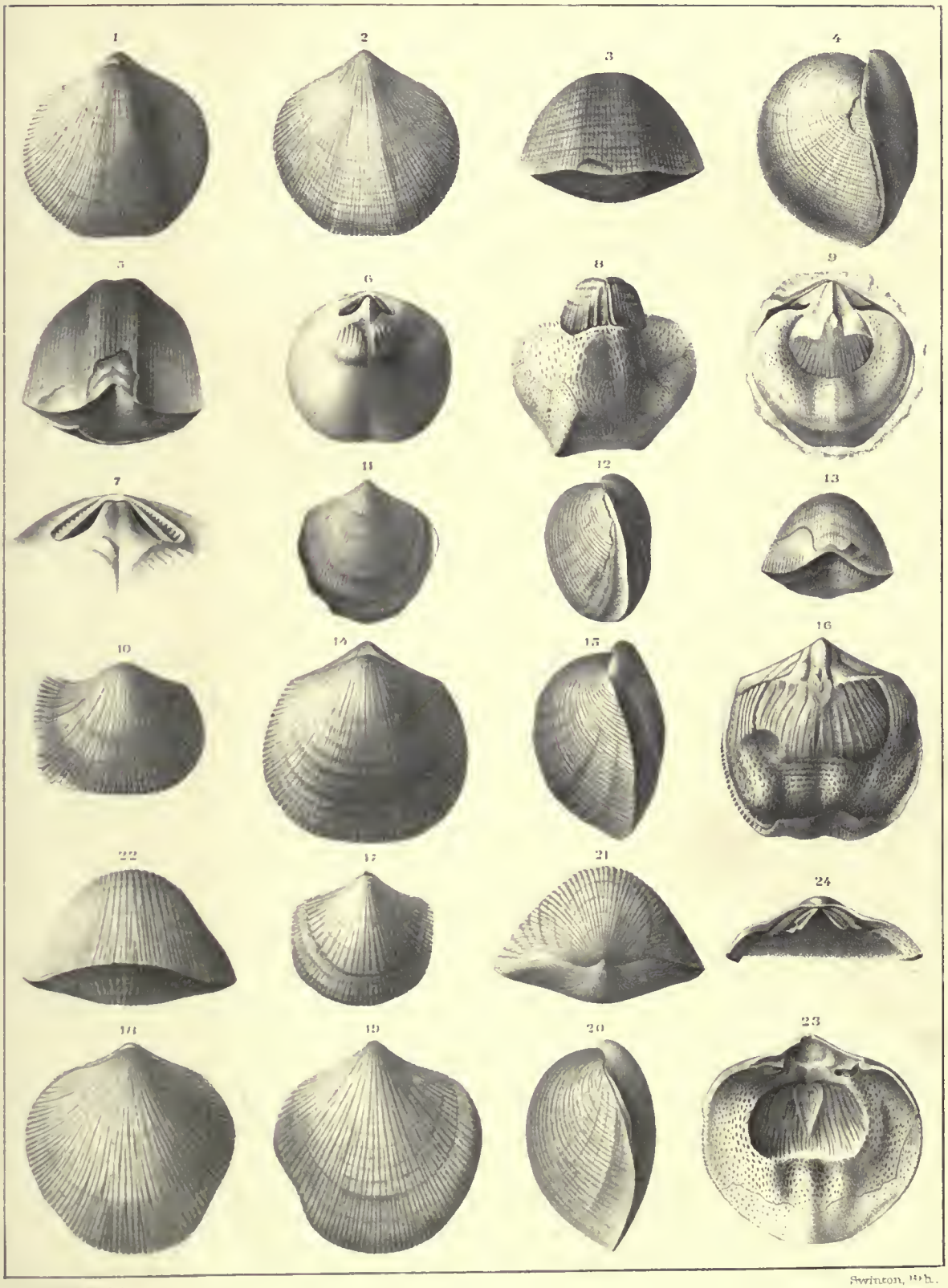

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PLATE 52.

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Figs. 1 – 12. ATRYPA RETICULARIS..... 316

1 – 3. Dorsal, profile and cardinal views of an extremely gibbous form of this species, from the Falls of the Ohio.

4 – 6. A very gibbous form with the ventral valve extremely elevated in front, and the surface with somewhat strong lamelloso lines. Specimens from the Bake-oven, Illinois.

7 – 10. Dorsal, ventral and profile views of large gibbous forms, in the Corniferous limestone of Albany and Schoharie counties. These specimens present many features in common with the *A. desquamata* of Sowerby, but the shells are more gibbous and the beaks less elevated. The foramen and deltidial area are not preserved in our species except in the young individuals. It is probable that they will eventually prove to be specifically distinct from the smaller forms referred to *A. reticularis*.

11. The interior of the ventral valve, showing muscular impressions and teeth.

12. A cast of the ventral valve of a smaller specimen, showing the muscular and vascular markings.

Figs. 13 – 19. CŒLOSPIRA CAMILLA (CONCAVA of text)..... 329

13, 14. Dorsal and ventral views of a specimen having the ordinary size and characters of those from the Lower Helderberg group; enlarged to two diameters.

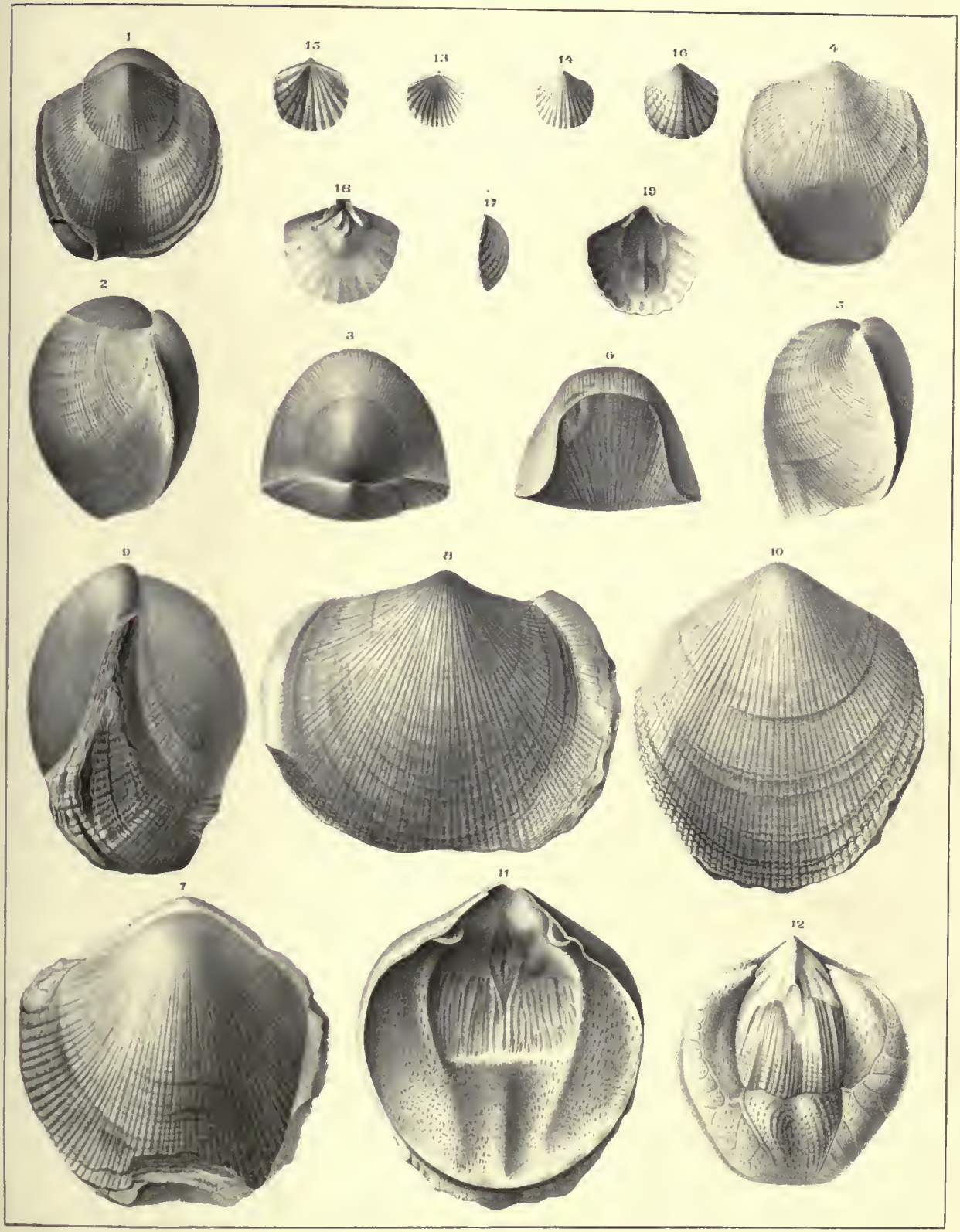
15 – 17. Dorsal, ventral and profile views of a larger and more coarsely plicated form; enlarged to two diameters.

18. Interior of the dorsal valve, showing the cardinal process and dental sockets.

19. Interior of the ventral valve, showing muscular impressions and teeth; enlarged to four diameters.

UPPER HELDERBERG GROUP.

(BRACHIOPODA.)



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Figs. 1, 2. ATRYPA PSEUDOMARGINALIS..... 327

1, 2. Dorsal and ventral views of an individual of the species.

Figs. 3–19. ATRYPA RETICULARIS..... 316

3. Dorsal view of a young individual which preserves the deltidial plates.
4. Enlargement of the beak of specimen, fig. 3, showing the deltidial plates and perforation of the beak.
5–7. Ventral, dorsal and profile views of a specimen of medium size, of the ordinary form of those from the shales of the Hamilton group of New York.
8. Ventral view of a larger individual, showing the extension of the lamellæ on the sides of the shell.
9. The interior of the dorsal valve, showing muscular impressions, hinge-plate, and crenulated socket plates.
10. An enlargement of the cardinal portions of specimen fig. 9, more clearly showing the characters of the hinge and points for the attachment of the crura.
11. The interior of a ventral valve, showing muscular impressions, teeth, etc
The specimens, figs. 3–11, are all from the shales of the Hamilton group, of New York.
12, 13. Dorsal and ventral views of a specimen, from Lime Creek, Iowa, supposed to be of the age of the Chemung group.
14, 15. Dorsal and profile views of a large form, common to the Hamilton group, at Independence, Iowa.
16. View of a large individual from Waverly, Iowa. The dorsal valve has been broken away, revealing parts of the spiral band and the loop connecting the cones.
17. Dorsal view of a well formed individual, from the Chemung group, of New York.
18. An impression of the ventral valve of a more coarsely ribbed specimen, from the Chemung group, of New York.
19. A cast of the ventral valve, of a very finely ribbed specimen, from the Chemung group. The form of the valve and the great extension of the cardinal border, presents considerable resemblance to those from Independence, Iowa; figs. 14, 15.

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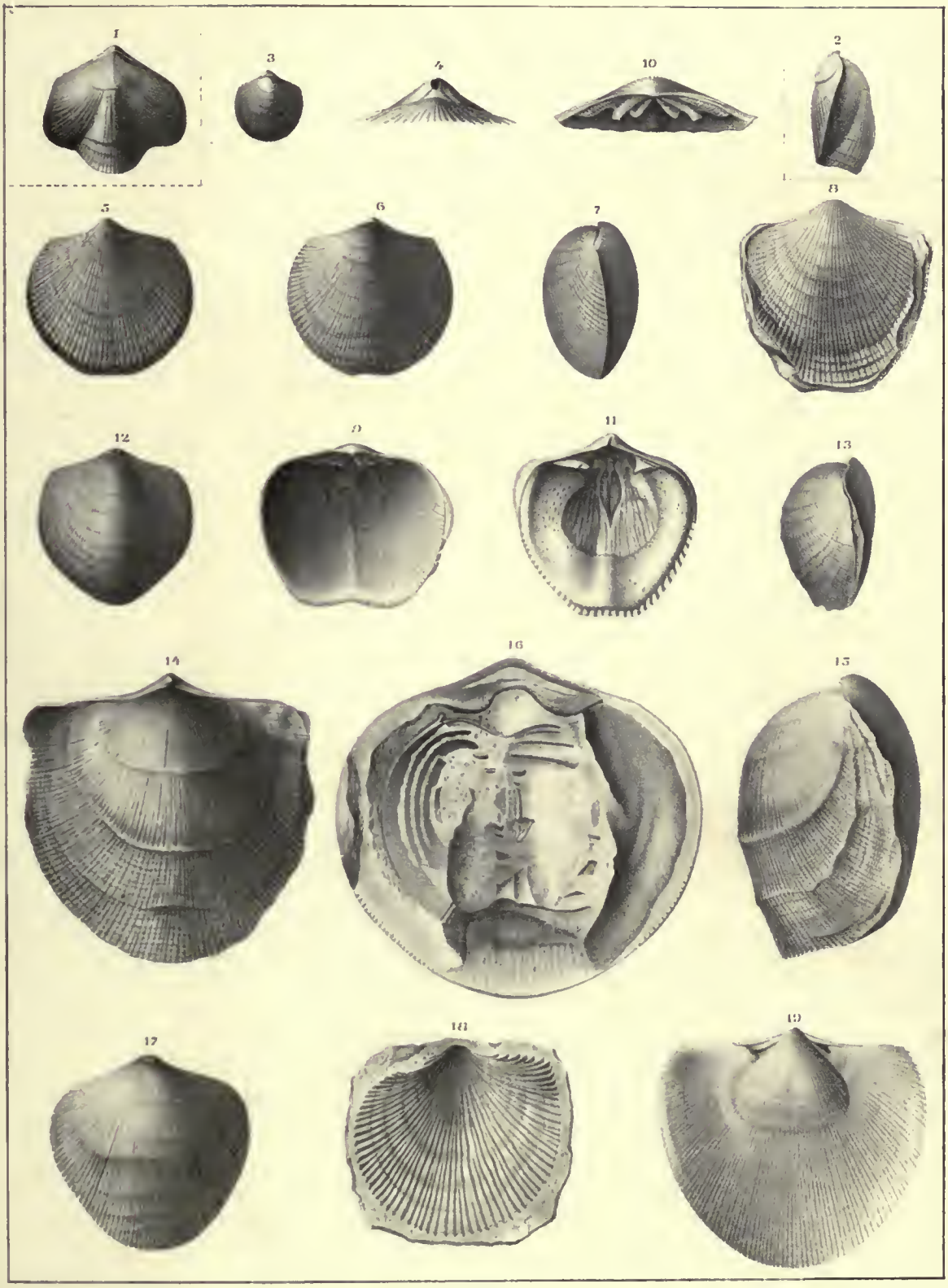

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Figs. 1 – 14, 18, 24, 25. ATRYPA SPINOSA..... 322

1. Dorsal view of a young individual, from the Corniferous limestone, showing the perforated beak, and the extended lamellæ near the margin of the shell.
2 – 4. Dorsal, ventral and profile views of a specimen, of the ordinary form and size of those from the Upper Helderberg limestones of New York.
5. Dorsal view of a large specimen from the Upper Helderberg limestone of New York.
6. The interior of a ventral valve, from the Falls of the Ohio.
7. The interior of an imperfect dorsal valve, from the Falls of the Ohio, showing the socket plates and muscular impressions; enlarged.
8, 9. Views of a small and medium sized specimen, from the Hamilton shales, showing the spines.
10, 12. Dorsal, ventral and profile views of a specimen of ordinary size, showing the surface denuded of the spines; from the Hamilton shales.
13. Dorsal view of a large specimen without spines, from the Hamilton group.
14. The interior of a ventral valve, showing muscular impressions, teeth, etc.
18. Dorsal view of a specimen, from the Chemung group, of New York.
24. Dorsal side of a specimen, showing the spires, crura and loop.
25. Ventral side of the same specimen, showing the position of the spires, loop and attachment of the crura to the hinge-plate. From the collection of Mr. R. P. Whitfield.

Figs. 15 – 17. ATRYPA HYSTRIX..... 326

15. Ventral view of a small specimen which preserves the marginal spines.
16. View of an individual preserving several spines to a length of nearly three-fourths of an inch.
17. View of an individual having very strong symmetrical plications.

Figs. 19 – 21. ATRYPA ASPERA var. OCCIDENTALIS .....

19 – 21. Ventral, profile and dorsal view of a specimen, showing the prevailing form of this species as it occurs at Independence, Iowa.

Figs. 22, 23. ATRYPA RETICULARIS..... 316

22. The ventral side of a specimen, showing the position of the spiral cones, with their attachment to the hinge-plate, and the loop connecting the spires.
23. Dorsal side of the same specimen. From the collection of Mr. R. P. Whitfield.

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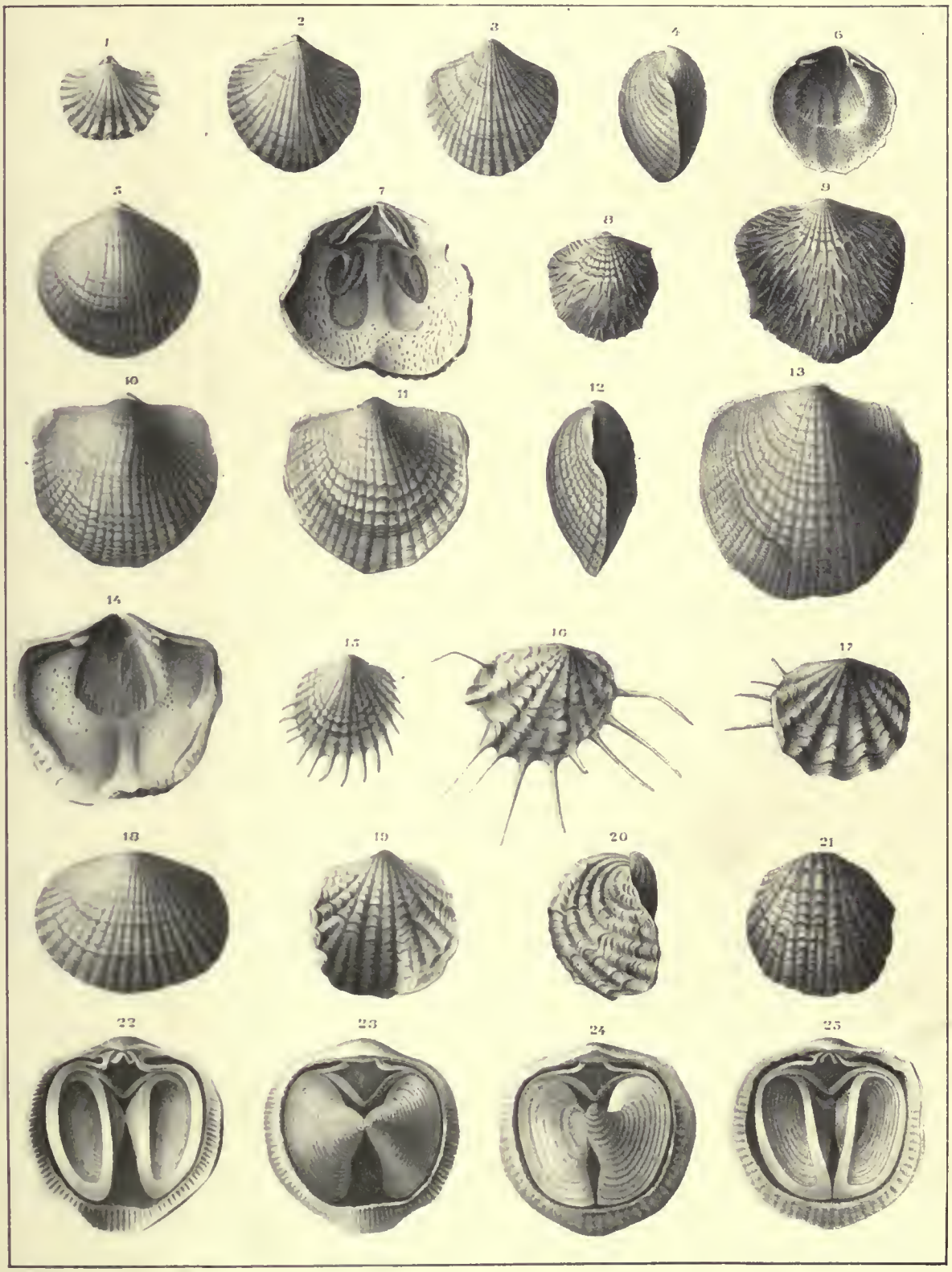

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Figs. 1–8. RHYNCHONELLA (STENOCISMA) TETHYS..... 335

1–3. Dorsal, ventral and profile views of a small specimen of the species.
4–8. Dorsal, ventral, profile, cardinal and front views of a large individual of the species.

Figs. 9–13. RHYNCHONELLA (STENOCISMA) BILLINGSI..... 336

9. An enlarged dorsal view of a young individual, specimen, fig. 11.
10. Enlarged dorsal view of another specimen.
11–13. Ventral, profile and front views of a specimen of this species.

Figs. 14–19. RHYNCHONELLA (STENOCISMA) CAROLINA..... 337

14–18. Dorsal, ventral, profile, cardinal and front views of a cast, showing the general features of the species.
19. Front view of a less gibbous specimen.

Figs. 20–23. RHYNCHONELLA (STENOCISMA) ROYANA..... 338

20–23. Dorsal, ventral, profile and front views of the specimen described.

Figs. 24–32. RYNCHONELLA (STENOCISMA) HORSFORDI..... 339

24. Dorsal view of a specimen of medium size, which is somewhat thickened on the margin.
25. Front view of a smaller individual.
26, 27. Dorsal and profile views of a more globose specimen.
28–32. Dorsal, ventral, profile, cardinal and front views of a large, well formed, and characteristic specimen of the species.

Figs. 33–43. RHYNCHONELLA (STENOCISMA) SAPPHO..... 340

33. Ventral valve of a specimen, referred with some doubt to this species. From the Upper Helderberg limestones.
34, 35. Dorsal and ventral views of a medium sized individual of the species.
36, 37. Dorsal views of two individuals of a larger size, showing some variation in the general outline of the shell
38–42. Dorsal, ventral, profile, cardinal and front views of a large and characteristic specimen of the species.
43. Front view of a still larger individual, showing a greater gibbosity.

Figs. 44–59. RHYNCHONELLA (STENOCISMA) CONGREGATA..... 341

44, 45. Dorsal and front views of a small globose form of the species.
46–50. Dorsal, ventral, profile, cardinal and front views of a full grown and characteristic specimen.
51, 52. Ventral views of casts of the species, showing considerable variation in the form of the muscular impressions.
53, 54. Ventral and cardinal views of a more elongated form, showing the cavities left by the removal of the dental lamellæ and hinge-plate; also the median septum and the filling of the small triangular fissure in the beak of the dorsal valve.
55. Dorsal view of a cast of this species.
56, 57. Enlargements of the cardinal parts of the casts of dorsal valves, showing the filling of the rostral cavities and fissure.
58, 59. Enlarged views of artificial casts made in the natural moulds of the dorsal valves, showing the hinge-plate, dental sockets, median septum and triangular fissures in different stages of development.

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Figs. 1 – 10. RHYNCHONELLA (STENOCISMA) PROLIFICA..... 343

1 – 3. Dorsal views, showing gradation in size and form.

4 – 6. Ventral, profile and front views of specimen, fig. 3.

7. Front view of a small specimen, in which the mesial elevation is not distinctly marked.

8 – 10. Dorsal, ventral and profile views of an unusually large specimen.

Figs. 11 – 20. RHYNCHONELLA (STENOCISMA) DOTIS..... 344

11 – 14. Dorsal, ventral, profile and front views of an individual of medium size, having sharply angular plications.

15 – 18. Dorsal, ventral, profile and front views of a broad form where the plications are rounded.

19, 20. Dorsal and front views of a more elongate form, showing a greater mesial elevation.

Figs. 21 – 23. RHYNCHONELLA (STENOCISMA) CARICA..... 344

21 – 23. Dorsal, ventral and front views of the specimen described.

Figs. 24 – 43. RHYNCHONELLA VENUSTULA..... 346

24, 25. Dorsal and front views of a small ventricose specimen.

26, 27. Dorsal and front views of a larger but less ventricose, and more finely plicated specimen.

28, 29. Ventral and front views of a specimen not fully grown, showing eight plications in the mesial sinus.

30 – 32. Dorsal, ventral and front views of an immature individual, with a slight elevation in front and only four plications in the sinus.

33. Front view of an immature specimen, showing six plications in the sinus.

34, 35, 37 – 39. Dorsal, ventral, profile, front and cardinal views of a full grown and gibbous specimen, having only five plications in the sinus. The ventral side is denuded of the shell and shows the vascular markings.

36. Enlargement of the specimen, fig. 35, to show the ramifications of the vascular lines, and their origin in the border of the muscular impressions.

40, 41. Dorsal and front views of an unusually broad individual.

42, 43. Front views of specimens which are extremely elevated in this part, with a maximum number of plications in the sinus.

Figs. 44 – 49. RHYNCHONELLA (STENOCISMA) CONTRACTA? var. (see ADDENDA). 351

44 – 48. Dorsal, ventral, profile, cardinal and front views of a characteristic specimen of this form.

49. Enlarged ventral view of a smaller specimen, showing a greater number of plications.

50, 51. Dorsal and ventral views of a specimen, with finer plications, resembling the *R.* (*S.*) *eximia*.

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Figs. 1 – 8. RHYNCHONELLA (STENOCISMA) EXIMIA 348

1. Dorsal view of a small individual of the species, showing no mesial elevation.
2, 3. Dorsal and ventral views of a larger specimen.
4 – 8. Dorsal, ventral, profile, cardinal and front views of a cast.

Figs. 9 – 16. RHYNCHONELLA (STENOCISMA) STEPHANI..... 349

9. Ventral valve of a young individual.
10. Ventral view of a cast of a larger specimen.
11, 12. Profile and front views of the cast of a dorsal valve, having narrow angular plications.
13 – 15. Dorsal, cardinal, and profile views of a cast, showing the characters of the dorsal portion of the hinge.
16. Ventral view of a cast, showing the muscular impressions.

Figs. 17 – 25. RHYNCHONELLA (STENOCISMA) DUPLICATA..... 350

17 – 20. Dorsal, ventral, profile and front views of a characteristic specimen of ordinary size.
21, 22 Casts of dorsal valves, showing muscular impressions, etc.
23. Cast of a ventral valve, showing muscular impressions.
24. An enlarged figure of a gutta-percha impression taken from specimen, fig. 22, showing the median septum, hinge-plate and crura, and a thickening of the cardinal portion of the interior.
25. An enlarged figure of a gutta-percha impression of specimen, fig. 23, showing muscular impression, teeth, etc.

Figs. 26 – 39. RHYNCHONELLA (STENOCISMA) CONTRACTA..... 351

26. Ventral valve of a small specimen with fine plications.
27. Dorsal valve of a specimen having stronger plications.
28. Ventral valve of a specimen, showing only two plications in the mesial sinus.
29 – 33. Dorsal, ventral, profile, front and cardinal views of a characteristic specimen of the prevailing size.
34, 35. Dorsal and cardinal views of a cast, showing the cavities left by the removal of the hinge-plate, teeth, septum, etc.
36. Ventral valve, showing four plications in the sinus.
37. Cast of a ventral valve of unusually large size.
38. Enlarged view of the cast of a ventral valve, showing muscular impression and filling of the rostral cavity. From the Hamilton group, four miles south of Cardiff, Onondaga Co., N. Y.
39. Ventral valve of a specimen of this species, from the Waverly sandstones of Ohio.

Figs. 40 – 46. RHYNCHONELLA (STENOCISMA) ORBICULARIS 353

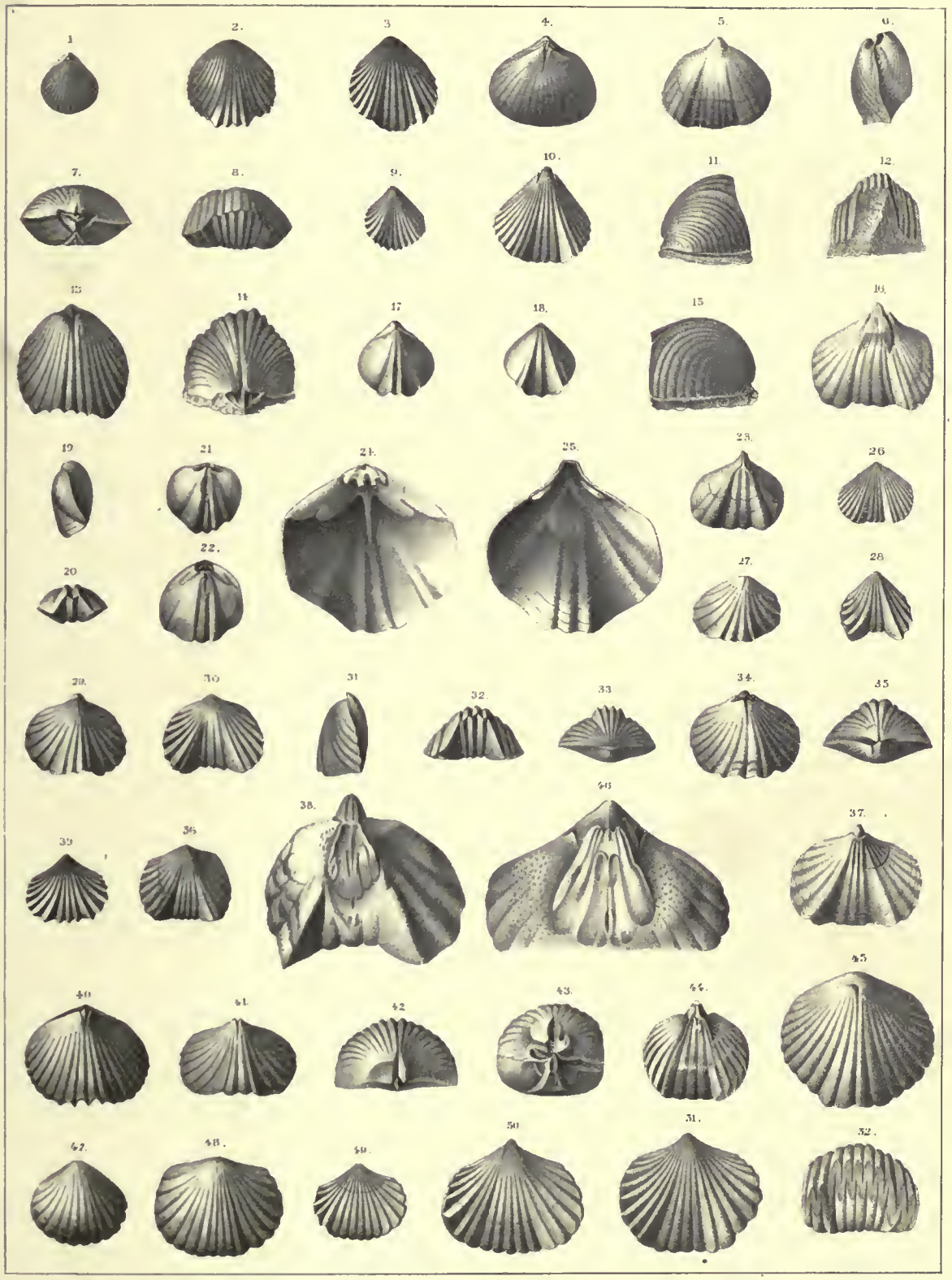
40. Cast of a dorsal valve, showing the triangular filling of the fissure in the hinge-plate.
41. Cast of a dorsal valve of a broader form, which approaches very closely to *R. contracta*.
42. Cardinal view of the cast of a dorsal valve.
43. Cardinal view of a cast, showing the cavities left by the removal of the hinge-plate, teeth, etc.
44. Ventral view of a cast, showing muscular impressions.
45. Dorsal view of the cast of a large specimen from Chautauque Co., N. Y. The other figures of the species are all from specimens collected near Meadville, Pa.
46. Enlargement from the cast of a ventral valve, showing muscular impressions and dental cavities.

Figs. 47 – 52. RHYNCHONELLA (STENOCISMA) SAPPHO var. 354

47, 48. Views of dorsal valves, showing some variation in form and number of plications.
49 – 51. Ventral valves of this species.
52. Front view of a crushed specimen.

CHEMUNG GROUP.

(BRACHIOPODA.)



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Figs. 1 – 5. LEIORHYNCHUS MYSIA 357

(The figures of this species are all enlarged to two diameters.)

1 – 3. Dorsal, ventral and profile views of a specimen of the ordinary size and characters of the species.

4. Dorsal view of another individual, having a less prominent beak and duplicate plications.

5. Dorsal view of an unusually large specimen, with sloping cardinal line.

Figs. 6 – 21. LEIORHYNCHUS LIMITARIS. 356

6 – 8. Dorsal and ventral views, and profile of a specimen of the usual form and size of those from the limestones in the Marcellus shale of Schoharie Co., N. Y.

9. Ventral view of another specimen, with fewer plications in the sinus.

10 – 12. Dorsal, profile, and front views of a somewhat larger specimen.

13, 14. Profile and front views of a very gibbous form, having numerous plications.

15 – 19. Dorsal ventral, profile, cardinal and front views of an unusually large and broad individual.

20. Front view of a very gibbous form, which is abruptly elevated in front and having only three plications in the sinus.

21. Dorsal view of a flattened specimen, from the thinly laminated black shales.

Figs. 22 – 25. LEIORHYNCHUS DUBIUS 364

22. Dorsal view of a specimen, with a slightly elevated mesial fold.

23 – 25. Dorsal, ventral and profile views of a specimen, with a more distinctly elevated mesial fold, and stronger plications.

Figs. 26 – 40. LEIORHYNCHUS MULTICOSTA 358

26. Dorsal valve of a young individual.

27. Dorsal valve of a larger individual.

28. Dorsal valve of a specimen of medium size.

29. Cardinal view of a gibbous specimen.

30. Dorsal view of a crushed individual of ordinary size.

31, 32. Ventral valves of elongated specimens, showing considerable variation in the plications.

33. Cast of a dorsal valve of unusually large size.

34, 35. Dorsal and ventral views of a young and much elongated specimen, from Widder, C. W.

36 – 40. Dorsal, ventral, profile, cardinal and front views of a full grown and well preserved individual, from the Hamilton shales of Canada.

Figs. 41 – 43. LEIORHYNCHUS IRIS 360

41 – 43. Dorsal, ventral and profile views of the specimen described.

Figs. 44 – 49. LEIORHYNCHUS QUADRICOSTATA 357

44. Dorsal valve of a crushed and flattened individual of small size.

45 – 48. Views of dorsal valves of this species, showing gradations in size.

49. Ventral valve of a large individual.

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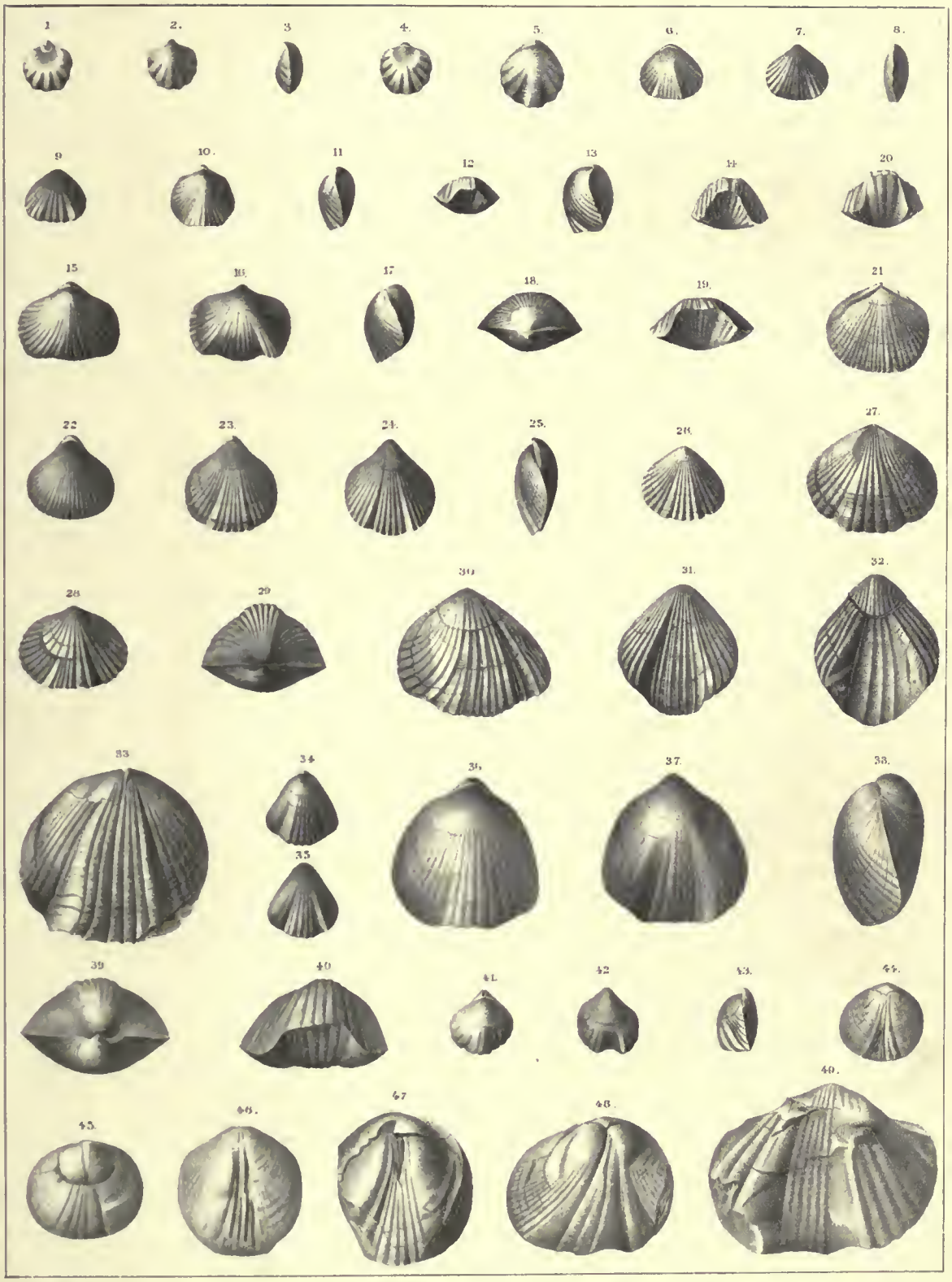

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Figs. 1–12. LEIORHYNCHUS KELLOGGI 361

1–3. Dorsal, ventral and profile views of a small individual.

4, 5. Dorsal and front views of an attenuated form.

6. Front view of a gibbous form, contrasting strongly with fig. 5.

7–11. Dorsal, ventral, profile, front and cardinal views of a full grown and characteristic specimen of the species.

12. Cardinal view of a cast, showing the cavities left by the removal of the dental lamellæ, hinge-plate and septum.

Figs. 13–17. LEIORHYNCHUS SINUATUS 362

13. Ventral valve of a small individual.

14–16. Dorsal ventral and front views of a small attenuated individual.

17. Front view of a more gibbous form.

Figs. 18–25. LEIORHYNCHUS MESACOSTALIS 362

18. Ventral valve of a small individual.

19. Ventral view of a larger individual.

20. Cardinal view of a large individual.

21–23. Casts of dorsal valves, showing variations in form, and number of plications in the mesial fold.

24. Ventral valve of a perfect and characteristic specimen.

25. Cast of a ventral valve, showing the muscular impression and a narrow mesial sinus.

Figs. 26–29. LEIORHYNCHUS GLOBULIFORMIS 364

26–29. Views of dorsal valves of this species, showing the rotundity of the shell and the form of the muscular impressions.

Figs. 30–39. LEPTOCŒLIA ACUTIPLICATA 365

30, 31. Dorsal and ventral views of a small individual, having a slightly concave dorsal valve.

32, 33. Dorsal and ventral views of a specimen of medium size.

34–37. Dorsal, ventral, profile and front views of a large and characteristic specimen of the species.

38. Interior of a dorsal valve, showing a slender median septum, cardinal process and dental sockets.

39. Enlargement of the interior of a ventral valve, showing the teeth and muscular impression.

Figs. 40–45. CAMAROPHORIA EUCHARIS 368

40–44. Dorsal, ventral, cardinal, front and profile views of a characteristic specimen of the species.

45. Ventral view of a specimen, showing the triangular or spoon-shaped cavity of the ventral valve.

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Figs. 1–21. PENTAMERELLA ARATA 375

1. Dorsal view of a young individual.
2–4. Ventral, dorsal and profile views of a small well formed individual.
5–8. Dorsal, ventral, profile and front views of a characteristic specimen of the ordinary size.
9. Cast of a large dorsal valve having peculiarly flexuose plications.
10. Cardinal view of a large cast, showing the cavities left by the removal of the parts of the hinge.
11, 12. Profile and front views of an unusually large and arcuate ventral valve. This and the foregoing specimens are all from the Schoharie grit of Albany and Schoharie counties, New York.
13–16. Dorsal, ventral, profile and front views of a specimen from the Upper Helderberg limestones of New York.
17, 18. Interior of dorsal and ventral valves, showing the hinge structure, from the Upper Helderberg limestones of New York.
19. Dorsal view of a specimen from the limestones at the Falls of the Ohio.
20, 21. Dorsal and ventral views of a specimen from the limestones at Waterloo, Iowa.

Figs. 22, 23. GYPIDULA LÆVIUSCULA..... 381

22, 23. Dorsal and ventral views of a specimen of this species.

Figs. 24, 25. PENTAMERELLA OBSOLESCENS..... 379

24, 25. Exterior and interior of a dorsal valve of this species, showing the small triangular pit and the flattened space or area on each side of it.

Figs. 26, 27. PENTAMERELLA MICULA..... 378

26. Exterior of a dorsal valve of the species.
27. Interior of a dorsal valve, showing the triangular pit.

Figs. 28–37. PENTAMERELLA PAPILIONENSIS..... 377

28, 29. Dorsal views of small individuals of the usual form.
30. View of a dorsal valve where the plications are somewhat angular, as in many examples of *P. arata*.
31–34. Dorsal, ventral, profile and front views of a full grown and characteristic individual.
35. Ventral valve of a crushed specimen, showing irregular plications and strong concentric lines of growth.
36. View of a specimen where the beak of the dorsal valve has been cut away to show the extent of the spoon-shaped process of that valve.
37. Interior of the ventral valve, showing its spoon-shaped process.

Figs. 38–43. PENTAMERELLA DUBIA..... 379

38, 39. Dorsal and ventral valves of a small individual.
40–43. Dorsal, profile, cardinal and front views of a large and characteristic specimen of the species.

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Figs. 1 – 8. GYPIDULA OCCIDENTALIS 380

1 – 5. Dorsal, ventral, profile, front and cardinal views of a very characteristic specimen, showing plications extending some distance from the margin of the shell.

6, 7. Profile and front views of another individual which is entirely destitute of plications.

8. An enlargement of the upper half of the shell, showing the area and foramen.

Figs. 9 – 20. RENSSELAERIA (?) JOHANNI 385

9. A dorsal valve of a young and moderately convex specimen.

10, 11. Dorsal and profile views of a larger and very ventricose specimen.

12. Ventral view of a specimen of medium size.

13 – 15. Dorsal, ventral and profile views of a crushed and somewhat distorted specimen.

16, 17. Dorsal and ventral views of a characteristic specimen, somewhat larger than the ordinary size.

18. Ventral valve of a very broad and unusual form.

19. Dorsal view of a cast, showing muscular impressions, dental cavities, etc.

20. Ventral view of a cast, showing the muscular and hinge-plate impressions.

Figs. 21 – 24. AMPHIGENIA ELONGATA..... 383

21 – 24. Views of specimens, showing gradations in size and varieties of form in young individuals of the species.

Figs. 25 – 27. AMPHIGENIA ELONGATA var. UNDULATA..... 384

25. Ventral view of a specimen from Mackinac, Michigan.

26. Interior of an imperfect ventral valve from the drift of Michigan, from Dr. C. Rominger.

27. Cast of a large ventral valve from the same source.

UPPER HELDERBERG & HAMILTON GROUPS.

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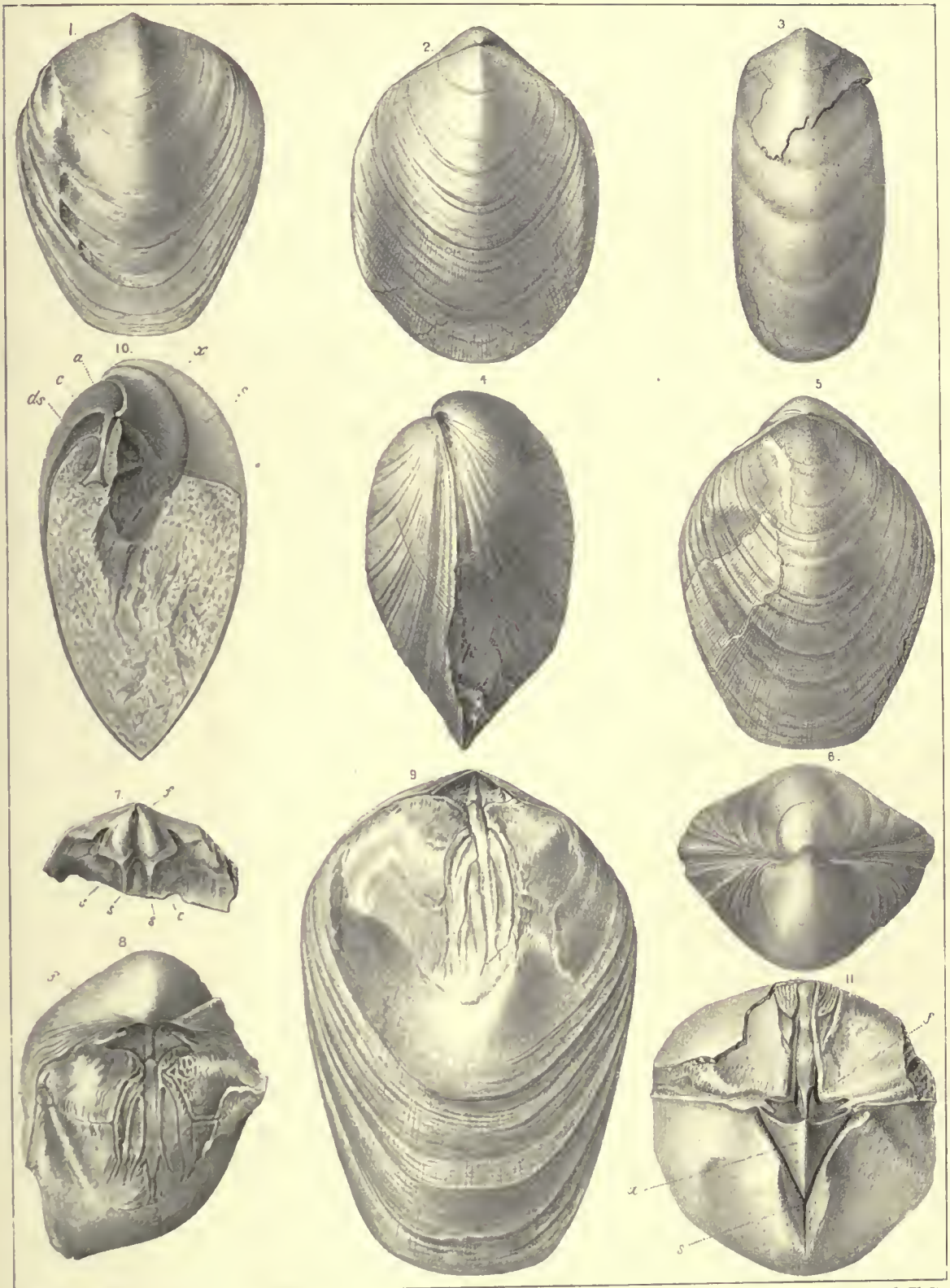
Figs. 1 – 11. AMPHIGENIA ELONGATA..... 383

1. Dorsal valve of a specimen of medium size.
2. Dorsal view of another individual of a more regularly elliptical form, showing a strongly striated surface.
3. Ventral side of a much elongated specimen preserving the shell on the upper part.
4 – 6. Profile, dorsal and cardinal views of a specimen of medium size and form.
7. Interior of an imperfect dorsal valve, showing the hinge-plate, dental sockets, vascular lines, etc. *c c*, points for the attachment of the crura; *f*, foramen which passes beneath the hinge plate and opens between the septa; *s s*, the double septum bordering the adductor muscular scar.
8. Dorsal view of a partial cast, showing muscular impressions and vascular lines, the cavity left by the removal of the hinge plate and at *f*, the filling of the foramen which passes from the beak beneath the hinge plate.
9. Cast of a large dorsal valve, showing the muscular impressions and the cavity left by the removal of the hinge plate, the filling of the foramen, etc.
10. Longitudinal section of a specimen, showing the septa and processes of both valves: *a*, the thickened shell of the dorsal valve; *c*, the crura with its expansion to form the loop; *d s*, dorsal septum; *s*, ventral septum; *x*, one of the dental lamellæ which unite on the septum to form the spoon-shaped process of the ventral valve.
11. Cardinal view of a large cast of both valves; *f*, the filling of the foramen of the dorsal valve, showing its connection with the interior; *s*, the cavity left by the removal of the septum; *x*, the filling of the inside of the spoon-shaped process.

UPPER HELDEBERG GROUP.

(BRACHIOPODA.)



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A.J. Ibbotson, del.

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Figs. 1 – 4. TEREBRATULA LENS 386

1 – 3. Dorsal, ventral and profile views of a specimen of the ordinary size and form.
4. Dorsal view of a larger but somewhat distorted specimen.

Figs. 5 – 10, 68. TEREBRATULA SULLIVANTI 387

5 – 7. Dorsal, ventral and profile views of a small specimen of the species, from Columbus, Ohio.
8. Dorsal view of an imperfect specimen, from Cayuga, Canada West.
9, 10. Dorsal and ventral views of a large imperfect specimen, from the same locality as the last.
68. Enlarged dorsal view of a specimen from Cayuga, C. W., showing the reversed loop. This feature, so far as yet ascertained, is peculiar to this species, and may possibly be due to accident in the specimen examined.

Figs. 11 – 16. TEREBRATULA HARMONIA 388

11. Dorsal view of a young individual.
12. Ventral view of a larger and broader form, from Cayuga, C. W.
13. The dorsal side of the same specimen cut down to show the loop.
14 – 16. Dorsal, ventral and profile views of a more elongated specimen. This, and specimen fig. 11, are from the Falls of the Ohio.

Figs. 17 – 25, 66, 67. TEREBRATULA RŒMINGERI 389

17 – 19. Dorsal, ventral and profile view of a large rotund form, from Hamburgh, N. Y., on the shore of Lake Erie.
20, 21. Dorsal views of two specimens from New York, one of them showing an emargination in front, and the other rounded; enlarged to two diameters.
22 – 24. Dorsal, ventral and profile views of a specimen from Michigan, showing a distinct emargination in front and a sinus on the ventral side; enlarged to two diameters.
25. Dorsal view of another individual from Michigan, which is destitute of sinus or emargination; enlarged to two diameters.
66, 67. Ventral and profile views of the loop of this species; enlarged from a specimen, from Michigan.

Figs. 26 – 28. TEREBRATULA ELIA 390

26 – 28. Dorsal, ventral and profile views of the specimen described.

Figs. 29 – 31. TEREBRATULA JUCUNDA 390

29 – 31. Dorsal, ventral and profile views of the specimen described.

Figs. 32 – 37, 71. TEREBRATULA LINCKLÆNI var 418

32. Dorsal view of a young shell of this species.
33 – 35. Dorsal, ventral and profile views of a full grown shell.
36, 37. Dorsal and profile views of a more gibbous form.
71. Ventral view of the loop, showing the disconnection at the anterior extremities.

Figs. 38 – 44. TEREBRATULA NAVICELLA 391

38 – 40. Dorsal, ventral and profile views of a large specimen of the species.
41. Dorsal view of a smaller individual.
42 – 44. Dorsal ventral and profile views of a more slender specimen of the species.

Figs. 45 – 48. TEREBRATULA ONTARIO 418

45. Dorsal view of a round symmetrical specimen.
46 – 48. Dorsal, ventral and profile views of a larger and slightly longer specimen.

Figs. 49 – 65. TEREBRATULA LINCKLÆNI 397

(This species referred with doubt to the Genus CRYPTONELLA on page 397, has proved to be a TEREBRATULA.)
49. Dorsal view of a young specimen.
50 – 52. Dorsal, ventral and profile views of a larger specimen.
53 – 55. Dorsal, ventral and profile views of a more gibbous specimen, which is much thickened on the front margin.
56, 57. Ventral and profile views of a small and very gibbous individual with strong varices of growth.
58, 59. Dorsal and ventral views of a young individual having a much broader or less elongated form than usual.
60. Dorsal view of a larger specimen of the same form with the last.
61 – 63. Dorsal, ventral and profile views of a full grown specimen of the broad form.
64, 65. Dorsal and ventral views of a cast of this species, showing the muscular lines and also the cavities near the beak left by the removal of the dental lamellæ.

Figs. 69, 70. TEREBRATULA SIMULATOR 391

69. Dorsal view of a specimen which has been cut to show the loop; enlarged to two diameters.
70. Profile view of the loop, showing the long crural processes; enlarged. The connexion at the anterior end is theoretically restored, but may have been connected during life by a ligament only.

(BRACHIOPODA)

Hyatt, del.

Hyatton, litho.

PLATE 61.

Page

Figs. 1 – 8. CRYPTONELLA RECTIROSTRA 394

1. Dorsal view of a small elongated specimen.
2 – 4. Dorsal, ventral and profile views of a larger and somewhat broader form.
5. Ventral view of a specimen of large size.
6 – 8. Ventral, dorsal and profile views of a broad unsymmetrical form of the ordinary size.

Figs. 9 – 27. CRYPTONELLA PLANIROSTRA 395

9 – 11. Dorsal, ventral and profile views of a young individual.
12, 13. Dorsal and ventral views of a larger specimen.
14 – 16. Dorsal, ventral and profile views of a specimen of the ordinary size and form of the species.
17. Enlargement of the rostral portion of a ventral valve, showing the foramen, deltidial plates and teeth.
18, 19. Dorsal and profile views of a much thickened and gibbous specimen.
20 – 22. Dorsal, ventral and profile views of an unusually large specimen, which is much thickened, giving great gibbosity of form. This form is much less common than that of figs. 14 – 16.
23, 24. Dorsal and ventral views of a cast of this species, from the Hamilton group of Hardy county, Va., showing the form of muscular impressions.
25. An enlarged ventral view of the loop of this species, showing its form and the existence of a band across the dorsal side near the base of the crura.
26. Dorsal view of a very large specimen referred with some doubt to this species. The specimen in this figure, is represented with the beak broken off, for the purpose of showing more clearly the filling of the rostral parts of the dorsal valve. The muscular impressions and groove left by the slender septum is faintly shown.
27. Ventral side of the same individual, retaining the beak and showing the muscular impressions of this valve.

Figs. 28 – 30. CRYPTONELLA IPHIS 396

28 – 30. Ventral, dorsal and profile views of the specimen described.

Figs. 31 – 41. CRYPTONELLA (TEREBRATULA) EUDORA 393

31, 32. Dorsal and ventral views of a small, thin specimen of the species
33. Dorsal view of a small individual, from the Waverly sandstones of Licking Co., Ohio, presenting all the specific characters of those from the Chemung group, of New York.
34, 35. Casts of dorsal valves, showing the muscular impressions.
36. Dorsal view of a cast, showing the cavities left by the removal of the teeth and dental lamellæ.
37 – 39. Ventral valves, showing a variety of form and proportions, resulting in some cases from distortion.
40. Ventral view of a specimen from which the shell is removed in the upper part, and partially preserved below.
41. Ventral view of an individual of the ordinary size, from the Waverly sandstones of Licking county, Ohio.

(In the progress of this volume it has often been necessary to print the descriptions in advance of making up the plates, and in the present instance the descriptions were printed in advance of the drawings of TEREBRATULA and CRYPTONELLA, and all the figures were referred to Plate 61. In consequence of a greater number of figures than anticipated, it has become necessary to designate an additional Plate as 61 A.)

HAMILTON & CHEMUNG GROUPS

(BRACHIOPODA.)

R. P. Whitfield, del

Swinton, lith.

PLATE 61 A.

Page

Figs. 1 – 21, 25, 26. CENTRONELLA GLANS-FAGEA 399

1, 2. Dorsal and ventral views of a large specimen of broader form than usual.
3 – 5. Dorsal, ventral and profile views; enlarged to three diameters, from a specimen of ordinary form. This, and the preceding specimen, are from the Schoharie grit.
6. Dorsal view of a large individual, from the Upper Helderberg limestone.
7. Dorsal view of a specimen from a drift pebble of limestone near Ann Arbor, Michigan, which has the dorsal valve entirely flat; enlarged to two diameters.
8 – 10. Dorsal, ventral and profile views of a large specimen from the Onondaga limestone of Erie county, N. Y.; enlarged to two diameters.
11 – 13. Dorsal, ventral and profile views of a very gibbous form, which shows the foramen and deltidium, enlarged to two diameters. The specimen is from the drift of Michigan.
14, 15. Dorsal and ventral views of a small specimen of somewhat different form, from the same locality as the preceding; enlarged to two diameters.
16. The interior of a dorsal valve, showing the muscular impressions, cardinal processes, the points for the attachment of the loop, and the dental sockets; enlarged to three diameters.
17. Dorsal view of a cast of a large specimen from the Schoharie grit, showing the muscular impressions, etc.; enlarged to two diameters.
18. The cast of a ventral valve from the Schoharie grit; enlarged to two diameters.
19. Dorsal view of a cast in chert from the drift of Michigan, showing the muscular imprints, the filling of the rostral cavity of the ventral valve retaining the imprints of the deltidial plates.
20. Enlargement of the loop of this species, taken from the ventral side showing its attachment to the hinge-plate of the dorsal valve.
21. Profile of the same.
25, 26. Dorsal and profile views of a very ventricose specimen having the character of *C. tumida*, Billings, but of smaller size. The specimen is from the Upper Helderberg limestone of Cayuga, C. W., and the figures are enlarged to two diameters.

Figs. 22 – 24. CENTRONELLA ALVEATA 401

22 – 24. Dorsal, ventral and profile views of the specimen described.

Figs. 27 – 29. CENTRONELLA HECATE 420

27 – 29. Dorsal, ventral and profile views of a specimen of this species from Cayuga, C. W.; enlarged to two diameters.

Figs. 30 – 38. CENTRONELLA IMPRESSA 402

30 – 32. Dorsal, ventral and profile views of a young and somewhat circular form.
33 – 35. Dorsal, ventral and profile views of a full grown specimen of the ordinary size.
36. Interior of a dorsal valve, showing the cardinal process and the strong callosities to which the crura are attached.
37. Interior of a dorsal valve of circular form, showing muscular and vascular markings; enlarged to two diameters.
38. Interior of a ventral valve, showing the teeth and deltidial plates.

Figs. 39, 40. CENTRONELLA GLAUCIA 403

39. Partial cast of a large dorsal valve.
40. Cast of a ventral valve, showing the muscular impression and filling of the rostral cavity.

Figs. 41 – 45. CENTRONELLA JULIA 419

41, 42, 43. Dorsal, ventral and profile views of a specimen of this species; enlarged to two diameters.
44. Ventral view of a large broad form; enlarged to two diameters
45, 46. Ventral and profile views of the loop of this species, made from specimens which have been broken, so as to show parts of the structure in different individuals from which this has been restored. Specimens loaned by Prof. A. Winchell.

Figs. 47 – 49. CENTRONELLA OVATA 419

47 – 49. Dorsal, ventral and profile views of the specimen described.

Figs. 50 – 52 TROPIDOLEPTUS OCCIDENS 408

50 – 52. Dorsal, ventral and profile views of a specimen of ordinary size.

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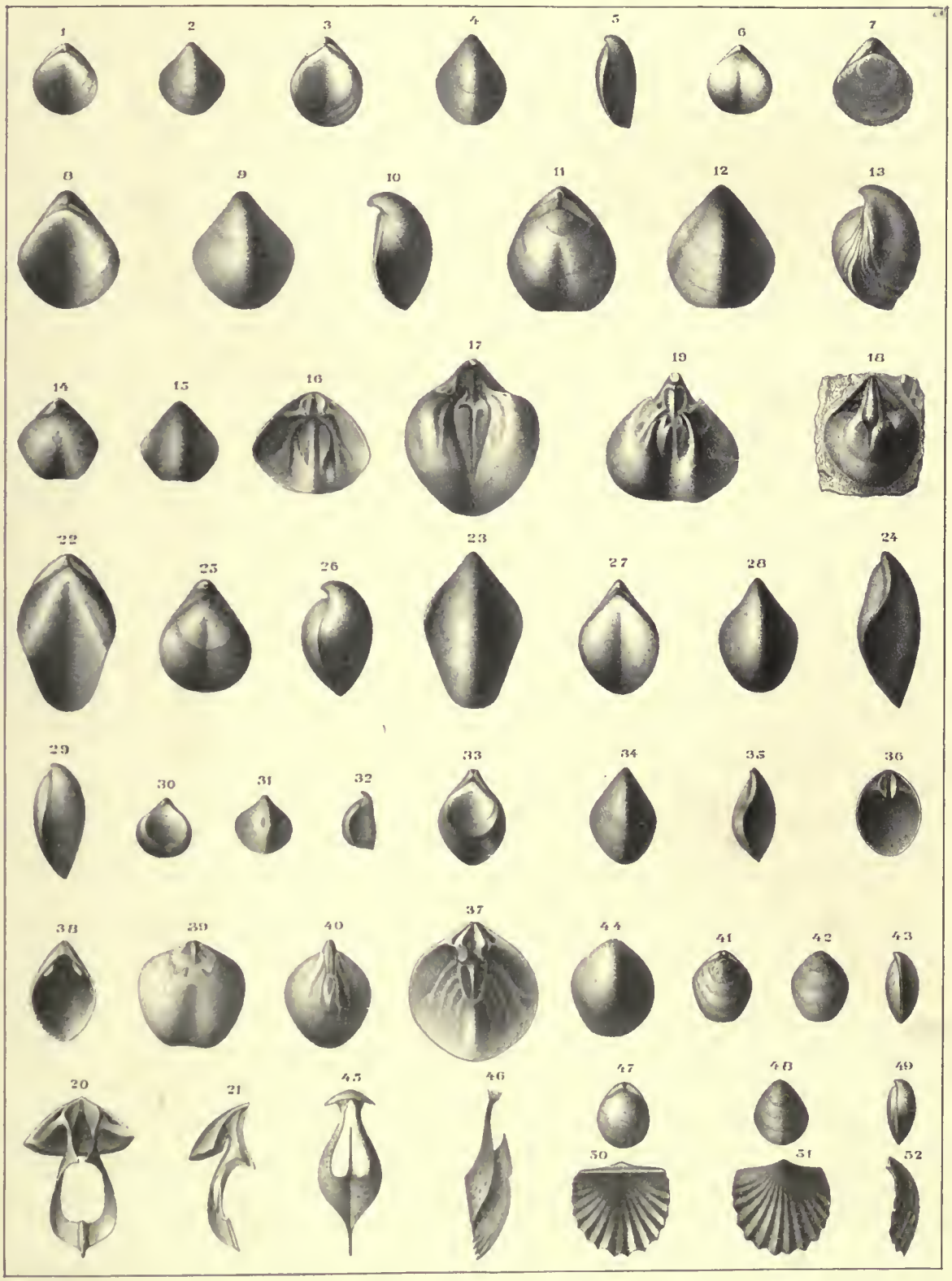

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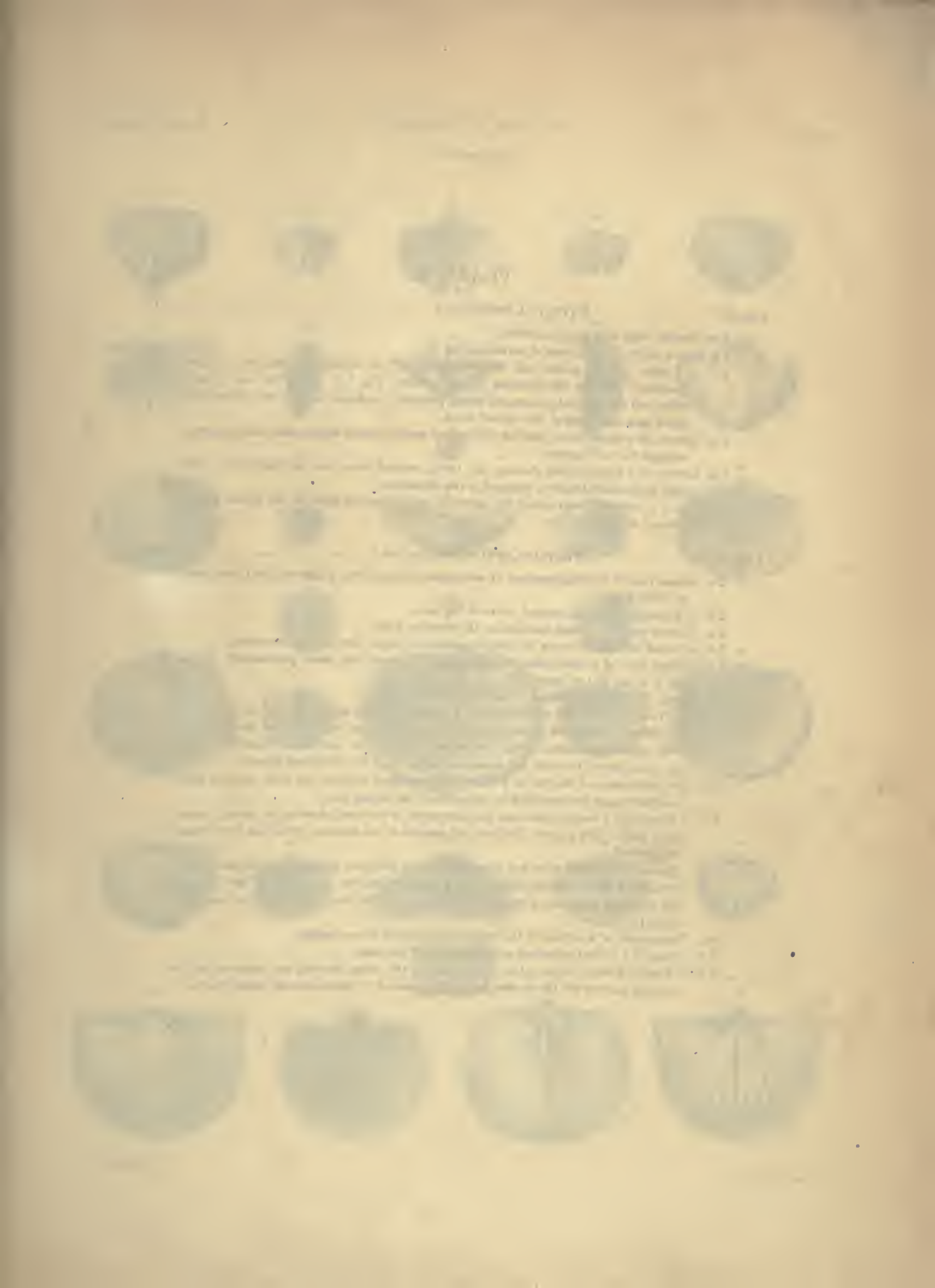


PLATE 62.

Page

Fig. 1. VITULINA PUSTULOSA..... 410

1 *a*. Ventral valve of a large individual.

1 *b*. Dorsal valve of a specimen of corresponding size.

1 *c–f*. Ventral, dorsal, profile and cardinal views of an individual; enlarged to three diameters, showing the pustules of the surface. Fig. 1 *f*, shows the area of each valve, and the cardinal process and socket plates of the dorsal valve as seen through the broad open deltidium of the ventral valve.

1 *g*. Interior of a dorsal valve, showing the cardinal process, dental sockets, and median septum; enlarged to two diameters.

1 *h*. Interior of a ventral valve, showing the teeth, cardinal area, and the thickening of the shell in the rostral cavity; enlarged to two diameters.

1 *i*. Cast of a ventral valve, showing the muscular impression and filling of the rostral cavity; enlarged to two diameters.

Figs. 2, 3. TROPIDOLEPTUS CARINATUS..... 407

2 *a*. Dorsal view of a young specimen of an elongated form; from Eighteen Mile Creek, shore of Lake Erie.

2 *b*. *c*. Enlarged dorsal and ventral views of the same.

3 *a*. Ventral view of a young specimen of the ordinary form.

3 *b*, *c*. Dorsal and ventral views of young specimens of larger size than the preceding.

3 *d*. Ventral view of an individual, showing finer plications than usual (erroneously printed fig. 4, in the text on page 408).

3 *e*. Dorsal view of an individual of medium size.

3 *f*, *g*, *h*. Ventral, dorsal and profile views of a specimen of the usual form and size.

3 *i*, *j*, *k*. Cardinal, ventral and dorsal views of a somewhat larger and thickened shell.

3 *l*. Dorsal view of an unusually large individual, showing the plications bifurcating beyond the usual size of the shell and becoming obsolete near the thickened margin.

3 *m*. An enlargement of the rostral portions of a specimen, showing the area, with the broad triangular open foramen filled by the callus of the dorsal valve.

3 *n*, *o*. Interior of a ventral valve and an enlargement of the same, showing the strongly crenulated teeth. The point of the beak and margins of the foramen, have been broken away or absorbed.

3 *p*, *r*. Interior of a dorsal valve and an enlargement of the same, showing the cardinal process, crenulated dental sockets, the projecting processes for the attachment of the loop, and the median septum which supports the outer end of the loop. (See wood cut page 406, of text.)

3 *s*. Enlargement of a portion of the surface, showing the strong punctæ.

3 *t*, *u*. Cast of a ventral valve and an enlargement of the same.

3 *w*, *x*. Cast of a dorsal valve and an enlargement of the same, showing the impression of the cardinal process and the cavities left by the removal of the crenulated socket plates.

HAMILTON GROUP.

(BRACHIOPODA.)

R.P. Whitfield, del

Swinton, Lith. Murray, Imp

PLATE 63.

(Supplementary.)

Page

Figs. 1 – 5. ORTHIS IDONEUS 52

1. Dorsal view of a small and somewhat distorted individual.
2 – 5. Ventral, dorsal, profile and cardinal views of a large and characteristic individual.

Figs. 6 – 13. SPIRIFERA MAIA 416

6, 7. Dorsal and ventral views of a young specimen.
8 – 11. Dorsal, ventral, profile and front views of an elongate specimen.
12. Dorsal view of a broadly oval form, where the cardinal line is short and gradually rounded.
13. Dorsal view of a partially exfoliated specimen, showing a large area.

Fig. 14. SPIRIFERA DISJUNCTA 243

14. Cast of a ventral valve, showing the impressions of the dental lamellæ reaching to the front of the valve.

Figs. 15 – 18. MERISTELLA ROSTRATA 307

15 – 18. Dorsal, ventral, profile and front views of the specimen described.

Figs. 19 – 22. MERISTELLA LENTA 420

19 – 22. Dorsal, ventral, profile and front views of a specimen of the ordinary size and form.

Figs. 23 – 25 RHYNCHOSPIRA SUBGLOBOSA 421

23, 24. Dorsal and ventral views of the cast of a specimen of medium size.
25. Dorsal view of the cast of a larger specimen which has been slightly distorted by pressure.

Figs. 26 – 29. LEIORHYNCHUS MULTICOSTA 358

26 – 29. Dorsal, ventral, profile and front views of a cast of this species, from Richmondville, Schoharie Co., N. Y.

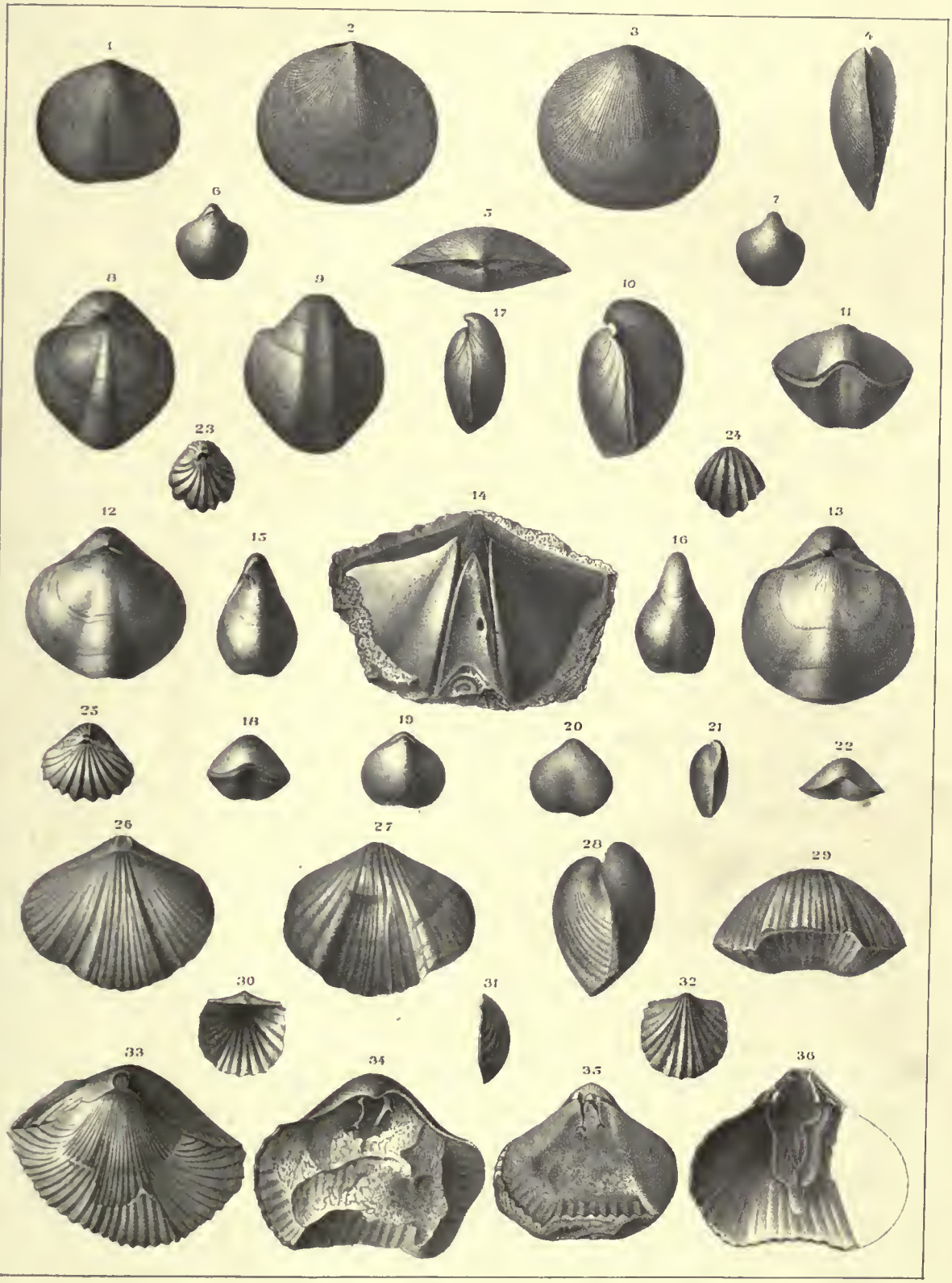
Figs. 30 – 32. STROPHODONTA PLICATA 114

30 – 32. Dorsal, profile and ventral views of the specimen described.

Figs. 33 – 36. TREMATOSPIRA (?) NOBILIS 412

33. Dorsal view of a crushed and distorted specimen retaining both valves, and showing the surface marking in a very perfect manner.
34. View of a dorsal valve, showing the beak and part of the crura.
35. Fragment of another dorsal valve, showing the impression of the crura and their attachment to the hinge-plate.
36. Interior of a ventral valve, showing the teeth and the elevated plate bearing the muscular impressions.

(BRACHIOPODA)
(Supplementary)



R.P. Whitfield, del. Swinton, lith.

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Natural history of New York

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